# GEOLOGY *of* DALLAS COUNTY TEXAS

*Dallas Petroleum Geologists*

REPRINTED AS

*FIELD & LABORATORY*

Vol. X December, 1941 No. 1

# FIELD & LABORATORY

*Jack Frost, Patron*

Published by

The Science Departments of

SOUTHERN METHODIST UNIVERSITY


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# GEOLOGY *of* DALLAS COUNTY TEXAS

*Dallas Petroleum Geologists*

December, 1941

To the Memory of

ROBERT T. HILL

# FOREWORD

At the regular monthly noon meeting of the Dallas Petroleum Geologists on Monday, May 5, 1941, a motion was passed authorizing the president to appoint a committee to work on a project which would culminate in a bulletin on the geology of Dallas County, Texas, to be in printed form prior to the annual meeting of the American Association for the Advancement of Science to be held in Dallas, Texas from December 29, 1941 to January 3, 1942. Those members appointed to the general committee were Messrs. C. C. Albritton, Jr. of Southern Methodist University, Robert I. Seale of Schlumberger Well Surveying Corporation, Henry J. Morgan, Jr., of Atlantic Refining Company, John W. Clark of Magnolia Petroleum Company, and John Gillin of National Geophysical Company. At the same time, an editorial committee composed of L. W. MacNaughton, C. C. Albritton, and W. G. Meyer was formed. Dr. Albritton consented to serve as chairman of the general committee and it was mainly through his unselfish efforts that the bulletin was completed within the few months available.

Time has not permitted sufficient study to consider this a final statement on the geology of Dallas County. It is the hope of the general committee, however, as well as the executive officers of our society, that revisions will be made in the near future so that more authoritative statements can be published on the geology of the county.

The Dallas Petroleum Geologists suffered a great loss on July 28, 1941 when Dr. Robert T. Hill, an honorary life member of the society, died. Dr. Hill, often called the "Father of Texas Geology," did some of his original work in Dallas County, which was included in his first scientific paper: "The Topography and Geology of the Cross Timbers and Surrounding Regions in North Texas," published in the *American Journal of Science* in 1887. We have therefore dedicated this bulletin to the memory of Dr. Hill.

The City of Dallas completes its one hundredth year of existence as this bulletin is being prepared. It is our hope that this account will contribute toward a better knowledge of the physical environment in which Dallas is located.

Many have aided the general committee, and sincere thanks are due them, particularly to Butler and Horn Drilling Company of Dallas who permitted the use of the Schlumberger electrical log on their No. 1 Sims well in Ellis County; Lane-Texas Company of Houston who permitted use of Schlumberger electrical logs on the water wells drilled at the North American Aviation, Inc. plant and at the Federal Women's Penitentiary; to the Southern Methodist University students of the 1941 summer class in field geology; David Trexler who compiled the areal geology; Dr. H. B. Stenzel who very generously furnished a check list of fossil crustacea from the Eagle Ford formation and certain illustrations; Dr. Ellis W. Shuler, head of the Department of Geology and Geography of Southern Methodist University, who permitted use of unpublished material on a sea reptile; Dr. E. J. Foscue of Southern Methodist University who made available many of his studies on Dallas County; M. H. West Company who permitted use of their map of the State of Texas; Dallas Blue Print Company who did much of the preliminary printing of the draft maps of Dallas County at cost; Dr. Herbert Gambrell whose knowledge of the history of Dallas County was a great help; and to E. E. Hurt, R. L. Hurt, and R. S. Taylor, who drafted the geological map of Dallas County and most of the other illustrations in the bulletin.

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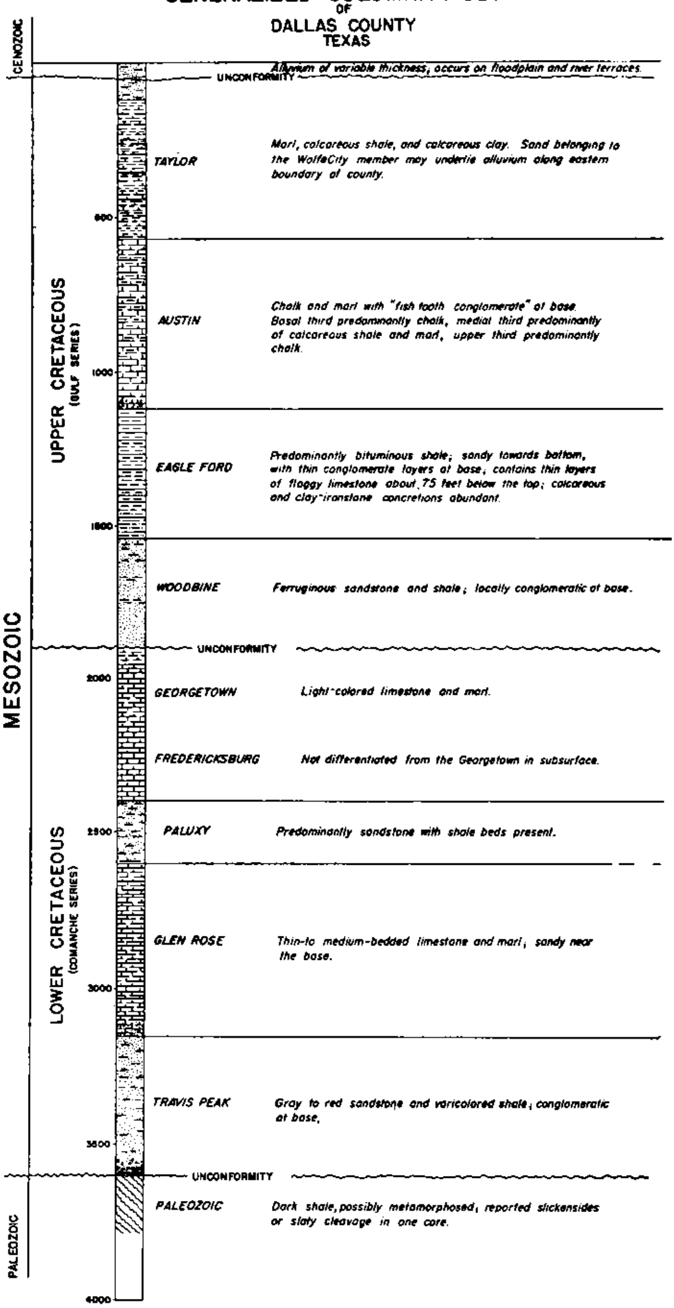
# PART I

# *Introduction*

PLATE III

## GENERALIZED COLUMNAR SECTION OF DALLAS COUNTY TEXAS



# DALLAS COUNTY

Dallas County, the location of which is shown in the State of Texas on Figure 1, covers an area of approximately 865 square miles. It was organized on March 30, 1846, when the First Legislature of the newly formed State of Texas approved the following act:

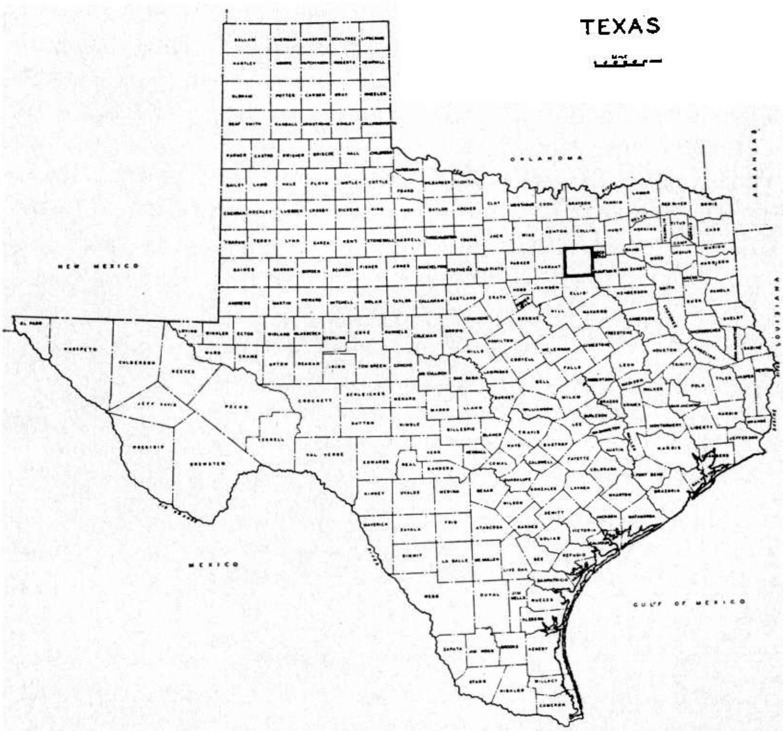



Figure 1.—Map of Texas showing location of Dallas County (in heavy lines).

### "AN ACT"

**Creating the County of Dallas**

Section 1. Be it enacted by the Legislature of the State of Texas, That all that territory included within the following limits, in Robertson and Nacogdoches counties, to wit: Beginning on the southern boundary line of Fannin county, three miles east of the eastern boundary of Peters' colony grant; thence, south thirty miles; thence, west thirty miles; thence north thirty miles to Fannin county line; thence, east with said line to be the beginning, be, and the same is hereby created a new county to be known and called by the name of Dallas.

Sec. 2. Be it further enacted, That the inhabitants residing within said limits, shall be entitled to all the rights and privileges enjoyed by the inhabitants of the several counties in the State, except as to the right of separate representation, until entitled by numbers to separate representation, and the rights of having a separate land district.

Sec. 3. Be it further enacted, That this act shall take effect from and after its passage.

The County of Dallas was named for George Mifflin Dallas, Vice President of the United States, who served with President James Knox Polk from 1844 to 1848. Records show that a committee went to Austin with the request that this county be named in honor of President Polk, but that a similar delegation from East Texas had arrived somewhat earlier in Austin with the same request. The Dallas Committee then decided to honor the Vice President of the United States. Although the city and the county have the same name, there is no evidence to show that they were named for the same person. It appears that the city was named for a Mr. Dallas who was a friend of John Neeley Bryan, the founder of the first settlement on the banks of the Trinity River on the present site of the city of Dallas. Although much research has been done, the Mr. Dallas for whom the city was named has never been further identified.

Dallas County, now one of the most important in Texas, has a population of 398,564, according to the 1940 census. The city of Dallas with a population of 294,734 in the same census, ranked 31st in the nation.

The city grew rather slowly from the time of its founding by Bryan, in 1841, to 1871 when the first railroad reached Dallas. By 1888 most of the railroads now entering Dallas had arrived so that the census of 1890 showed a large increase in growth during the previous decade. Then as Dallas became a distributing center for a large part of the Southwest, its population grew rapidly. The following statistics show the growth of both the city and county of Dallas by decades:

| Year | City of Dallas | County of Dallas |
|---|---|---|
| 1850 | ? | 2,743 |
| 1860 | ? | 8,665 |
| 1870 | 2,967 | 13,314 |
| 1880 | 10,338 | 33,488 |
| 1890 | 38,067 | 67,042 |
| 1900 | 42,638 | 82,726 |
| 1910 | 92,104 | 135,748 |
| 1920 | 158,976 | 210,551 |
| 1930 | 260,745 | 325,791 |
| 1940 | 294,734 | 398,564 |

Dallas County enjoys a relatively mild and humid climate. Average annual temperature ranges and average distribution of rainfall are shown in Figure 2.

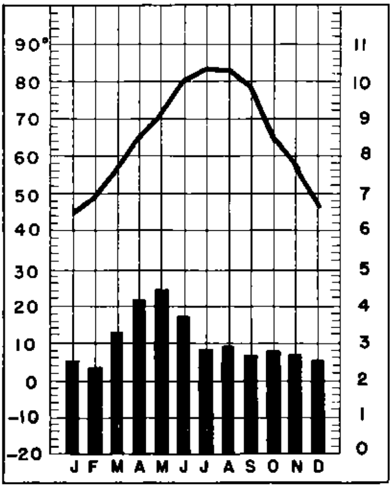



Figure 2.—Chart showing average ranges of temperature and rainfall for Dallas. Numbers on right column indicate inches precipitation; those on left indicate degrees temperature. (Courtesy E. J. Foscue).

According to the latest Texas Almanac, Dallas is the principal commercial, jobbing and wholesaling, retailing, and financial center of the Southwest, and is the home of the Federal Reserve Bank of the Eleventh District. It is the fourth most important insurance center of the United States. Its manufacturing industries include among others, cotton gin machinery, machine job products, automobile assembling, oil machinery, furniture, cement, food processing plants, leather and saddle plants, cotton seed products, packing products, flour mills, and beverages. The educational institutions of this city are Southern Methodist University, Baylor College Medical School, Hockaday School, and Texas Country Day School. The State Fair of Texas, the largest of its kind in the nation, is held annually in its permanent plant at Fair Park. The city is represented culturally by many organizations, among which are the Little Theatre, the Museum of Natural History, the Dallas Symphony Orchestra, Museum of the Dallas Historical Society, the Art Museum, and the Civic Federation.

With the development of air travel, Dallas is again receiving benefit from transportation through its development of Love Field as an outstanding commercial airport.

Physiographically, Dallas County lies within the Western Gulf Coastal Plain near its inner boundary and is largely in the Black Prairie belt on the outcrop of the Eagle Ford, Austin and Taylor formations. Structurally, the county lies between the Fort Worth basin on the west and the East Texas Basin on the east. The Mexia fault zone lies to the east in neighboring Kaufman County. The Balcones fault zone is believed by some to extend as far north as Dallas County, but all faults observed at the surface here are of such small magnitude as to render this contention very doubtful. Many geologists believe that the buried Ouachita structure passes through or near Dallas County. It is certain that the Cretaceous rocks in this general area conceal a pre-Cretaceous record which, if known, would reveal an interesting and complex geologic history.

During the greater part of Cretaceous time, the area now represented by Dallas County was covered by seas in which accumulated the sequence of rocks shown in the column on Plate III. The Cenozoic record is represented only by terrace and flood-plain deposits all of fluvial origin, and whatever marine Tertiary sediments may have formerly been over the site of Dallas County have been eroded away subsequent to their deposition.

# PART II

# *Surface Geology*

# CRETACEOUS ROCKS

Three formations of the Gulf Series—the Eagle Ford, Austin, and Taylor—are exposed at the surface in Dallas County. Descriptions of these are in following sections of this report, but some notice should be given at this point of the correlations that have been made between the local section and the type section of the Cretaceous in Europe. Such correlations have been made by Scott (1926, p. 24, 118, 189-190), Adkins (1932, p. 270-271), and by Stephenson and Reeside (1938, p. 1631). All are agreed that the greater part of the Eagle Ford is Turonian, and that the basal beds of this formation are Upper Cenomanian. The Austin, in turn, is compred with the Coniacian and Santonian. Scott, Stephenson, and Reeside correlate the lower Taylor with the Campanian, but Adkins considered these same beds equivalent to the Upper Santonian.

Earlier maps of the county indicate that the Woodbine, basal formation of the Gulf Series beneath the Eagle Ford,

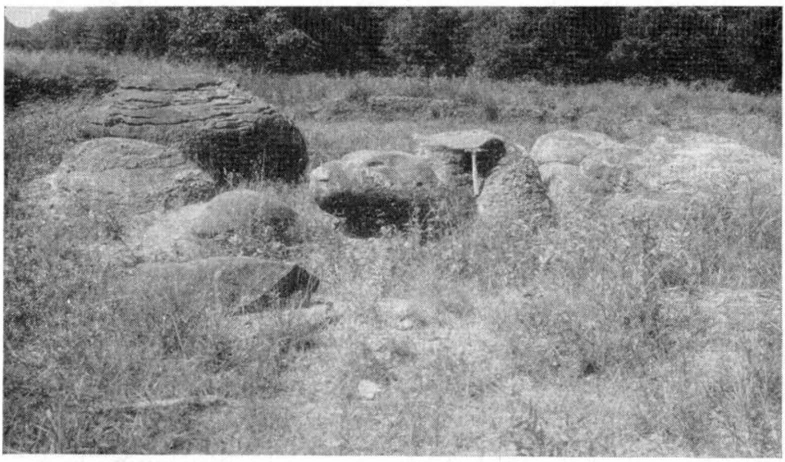


Figure 3.—Large sandstone concretions from the Woodbine, reworked into Pleistocene terrace gravel, Bear Creek, western Dallas County.

crops out in the extreme western part of the county. No Woodbine outcrops were found in Dallas County during the course of field work, although special effort was made to locate them. Gravels along Bear Creek at the county line contain huge sandstone concretions that enclose fossils characteristic of the Woodbine (Fig. 3), and it is unlikely that these large bodies have been transported very far from their sources. The Woodbine may therefore extend into the county along Bear Creek, West Fork, and other streams along the western county line, but in case it does, it is evidently concealed by alluvium.

## EAGLE FORD FORMATION

### TYPE LOCALITY AND THICKNESS

The Eagle Ford formation consists mostly of clay-shale. Within the county it has an average thickness of about 475 feet. Hill (1887, p. 296, 298) named the formation for exposures around the small settlement of Eagle Ford, which is situated on the south side of the Trinity north of Arcadia Park (Pl. 1).

### OUTCROPS

Over most of western Dallas County, where the Eagle Ford should normally crop out, the shales are covered by alluvium. Good exposures are restricted to upland areas that stand above the higher river terraces, to belts along streams that are actively eroding the shales, and to artificial excavations along the highways and railroads or in clay and cement workings.

The formation is well exposed along slopes flanking the White Rock Escarpment south of Trinity River. Some of the more interesting localities are: (1) at the quarries of the Trinity Portland Cement Co. (2) along the Dallas-Fort Worth highway in the Arcadia Park area (3) along Mountain Lake pike west of Ledbetter road, and (4) one-half mile west of the intersection of Anderson and Mansfield roads in the undercut banks of a Mountain Creek tributary. An excellent exposure, well known to collectors of fossils, is along the right bank of Elm Fork at the crossing of the Chicago, Rock Island and Pacific railroad. There are many small cuts in the shales along Hackberry Creek and along State Highway 114 west of Belt Line road. Shuler (1918, p. 14-18) states that a fifty-foot section of the shale is exposed in a bank of the Trinity where it makes a sharp bend north of Grand Prairie.

#### LITHOLOGY AND CHEMICAL COMPOSITION

The basal beds of the Eagle Ford, exposed short distances beyond the western boundary of the county, have been described by Taff (1893, p. 292), Moreman (1927, p. 90), and Adkins (1932, p. 425-426). At the base is a thin conglomerate layer which overlies the upper Woodbine. This is succeeded upward by sandy clay and shale with partings of impure limestone and calcareous concretions. The material becomes less sandy upward in the section, the sand persisting in recognizable quantity up to levels between 15 and 90 feet above the base. As the sand decreases in quantity the shale changes color, from brownish and brownish-gray at the bottom to dark gray, sometimes with a bluish cast, higher in the section. Moreman (1927, p. 90) notes that the shale becomes highly calcareous and almost white beginning at a horizon approximately 150 feet above the base. These light-colored calcareous shales are around 50 feet thick, and grade upward into dark gray and bluish gray shales which are about 200 feet thick. At many horizons these shales contain concretions and lentils of dense gray limestone and ferruginous claystone.

Flaggy limestone breaks the shale sequence 75 feet below the top of the Eagle Ford at Arcadia Park. These beds, well exposed in cuts along the Dallas-Fort Worth highway at the western edge of the town, have a thickness of one foot. They consist of gray to brownish, brown-weathering limestone containing considerable clay, silt and fine sand, and bedded in units from a fraction of an inch to three inches thick. On the rough and irregular surfaces of bedding are numerous fossils including small ammonites, pelecypods, fish teeth, and worm (?) castings. One specimen from this locality appears to be made largely of foraminiferal sand, with the fragile shells of *Globigerina* and *Guem-*

*belina* predominating. Other portions of the rock are made of calcareous shell fragments. The fossils are not uniformly distributed through the flags, however, and some layers appear to be barren, as Scott (1940, p. 312-313) has observed.

Flaggy material of the same character as that described above is exposed along the west side of Ledbetter Road about one mile south of Arcadia Park. The main flaggy layer is slightly over one foot thick, but for six inches above the top there are alternating layers of clay and impure limestone, the latter in units averaging a quarter of an inch thick. Other exposures of the flaggy layers may be seen along Mountain Lake pike near its intersection with Blue Cut road. Between the flaggy layers and the top of the formation is a thickness of 75 feet, mostly dark gray to black shale. These upper beds are well exposed in the railroad cut directly south of the Dallas-Fort Worth highway between Arcadia Park and Chalk Hill, in the embankments along the same highway at Chalk Hill, and in the quarry of the Trinity Portland Cement Co. (Fig. 4)

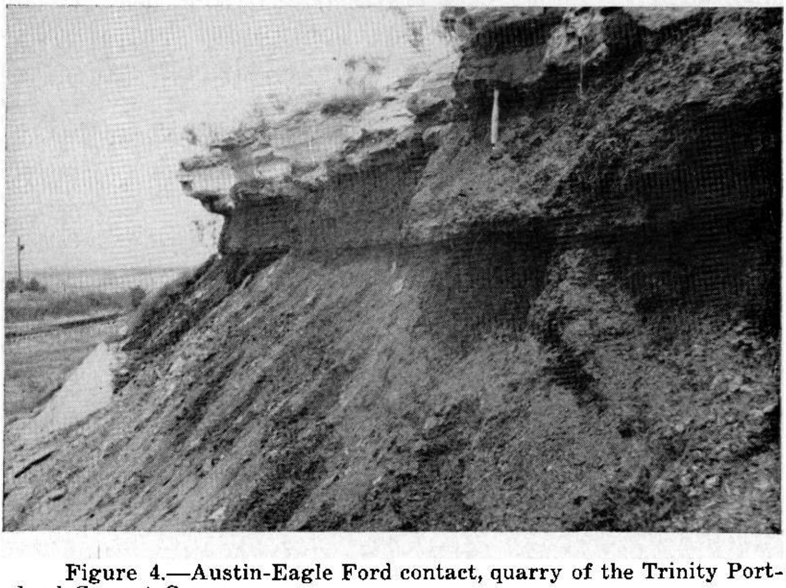


Figure 4.—Austin-Eagle Ford contact, quarry of the Trinity Portland Cement Company.

In the railroad cut mentioned above, about 35 feet of shale is exposed. Unweathered shale near the bottom of the excavation is dark gray or black with yellow and brownish limonitic stains on many of the bedding surfaces. These surfaces are commonly set with minute selenite crystals which are so abundant in places as to give a sparkling appearance to the shale. Concretions of dark gray limestone, ranging in diameter from an inch to three feet, are set in the shale, and are concentrated along two levels paralleling the bedding 10 and 13 feet below the top of the cut.

The uppermost beds of the Eagle Ford are best exposed in the Trinity Portland Cement quarry, where they consist of alternating thick units of shale and thin beds of impure limestone, as indicated by the following section.

**Section at Quarry of the Trinity Portland Cement Co., 100 Yards East of Cement Road**

| | Thickness—feet |
|---|---|
| *Austin formation* | |
| 12. White chalk; top not exposed | 2.0 |
| 11. Gray shale | 0.4 |
| 10. Gray impure pebbly chalk with round chalk cobbles and small septaria up to 5 inches across scattered along base; small dark pebbles representing internal casts of gastropod and pelecypod shells abundant at base and scattered throughout. Lower contact sharp, undulatory. | 0.8 |
| *Disconformity* | |
| *Eagle Ford formation* | |
| 9. Dark gray shale, containing *Alectryonia lugubris* | 1.4 |
| 8. Flaggy gray limestone made very largely of shell fragments | 0.1 |
| 7. Dark gray shale | 0.2 |
| 6. Flaggy gray limestone made very largely of shell fragments | 0.1 |
| 5. Dark gray shale | 1.2 |
| 4. Flaggy gray limestone made very largely of shell fragments; maximum | 0.4 |

| | | |
|---|---|---|
| 3. | Dark gray shale | 0.3 |
| 2. | Granular gray limestone made very largely of shells, including many partially complete and complete valves of *Alectryonia lugubris* | 0.1 |
| 1. | Dark gray shale | 4.0+ |

Ries (1908, p. 71; 1927, p. 556) has published analyses of the Eagle Ford shales in connection with his writings on clays. These are reproduced in the table below. Although the exact localities from which the samples were taken are not given in the original publications, these analyses show something of the chemical characteristics of the shales in general.

**Chemical Analyses of Eagle Ford Shales (After Ries)**

| | Dallas County 1 Sample | Average of 8 Analyses (Localities not specified) | | |
|---|---|---|---|---|
| | | Maximum | Minimum | Average |
| Silica | 55.10 | 67.00 | 34.60 | 55.74 |
| Alumina | 23.80 | 23.80 | 15.02 | 20.00 |
| Ferric oxide | 3.51 | 6.48 | 1.87 | 4.17 |
| Lime | 3.28 | 21.48 | Trace | 4.07 |
| Magnesia | 1.24 | 2.09 | 0.15 | 1.35 |
| Potash | 0.50 | 1.65 | Trace | 0.73 |
| Soda | 0.21 | 2.00 | 0.05 | 1.07 |
| Titanic acid | 1.05 | 2.10 | 0.96 | 1.52 |
| Water | 6.00 | 7.06 | 5.20 | 6.06 |
| Carbonic acid | 1.75 | 15.60 | Trace | 2.79 |
| Organic matter | ........ | 3.00 | | 1.55 |
| Sulphur trioxide | 3.37 | 3.37 | | 0.79 |

The shales contain a comparatively large amounut of organic material (Ries, 1908, p. 72). It is to this finely divided bituminous substance, in fact, that the dark shales owe their color. The high content of sulphur trioxide is ascribed to the presence of gypsum and iron sulphide (marcasite or pyrite). Ries suggests that as a result of decomposition of the iron sulphide there was formed sulphuric acid, which reacted with calcium carbonate in the shale to produce the hydrous calcium sulphate or gypsum.

#### PROPOSED SUBDIVISIONS

Moreman has divided the Eagle Ford into three units: the Tarrant, Britton, and Arcadia Park, in ascending order. The type locality for the Tarrant is one mile east of Tarrant Station at the crossing of the St. Louis, San Francisco and Texas railway over a tributary of Bear Creek. This locality is in Tarrant County a short distance west of the Dallas county line. The intermediate unit is named for Britton, in northwestern Ellis County, and the upper unit for Arcadia Park, Dallas County. A brief account of the lithology of these divisions, as defined by Moreman, has been given by Adkins (1932, p. 424-426).

The Tarrant consists predominantly of sandy clay and limestone, aggregating about 15 feet in thickness. The sandy clay, gray and brownish gray in color, is parted by thin beds of brownish limestone and limestone concretions. The base is marked by phosphatic pebble-conglomerate and the top is defined by a layer of limonitic material less than an inch thick.

The Britton consists mostly of blue clay with a few flaggy limestone seams and concretions, the latter becoming more abundant toward the top. This division is said to have a maximum thickness of 300 or more feet in the latitude of Dallas.

The Arcadia Park is predominantly shale. At the base of the section in the type area is 20 feet of blue clay. This is followed by 1 to 3 feet of flaggy limestone, which in turn is succeeded by 75 feet of shale containing numerous calcareous concretions. The total thickness is given as approximately 100 feet.

Adkins (1932, p. 425) considers Moreman's three subdivisions as separate formations which together comprise the "Eagle Ford group". On the geological map accompanying this report (Plate 1) the Eagle Ford is not subdivided. It may be noted, however, that the shales cropping out along the east side of Mountain Creek would belong to the Arcadia Park and upper Britton. In the northern part of the county, the shales directly adjoining the outcrop of the Austin are of the Arcadia Park unit. The greater part of the shales showing at the surface west of Elm Fork belong to the Britton, although some of the shales along the western boundary of the county may be Tarrant.

There is some question regarding the advisability of retaining Moreman's subdivisions as formational units. The Tarrant may be useful as a name to designate the basal sandy facies of the Eagle Ford, but however it is regarded one has considerable difficulty in fixing a top to this unit. Data from well logs in the county indicate that the Eagle Ford is in places perceptibly sandy as high as 90 feet above the base, so that there would be little justification for setting the basal 15 feet apart from the remaining 75 as a distinct formation. As originally defined, the Arcadia Park includes 20 feet of bluish-gray clay at its base. This basal clay would seem to be more logically grouped with the Britton, from which it cannot be distinguished lithologically. The most distinct break in the entire shale sequence is at the flaggy layers placed 20 feet above the base of the Arcadia Park at the type locality. If the Eagle Ford is to be subdivided, it would seem logical to designate these flags by a separate name, or at least to place them at the base or top of a subdivision.

Since the Eagle Ford in the Dallas area is relatively homogeneous as compared with stratigraphic units regarded as formations elsewhere, and since the proposed subdivisions are not set apart by structural or sharp lithological breaks such as permit of ready correlation from place to place, it seems better to regard the Eagle Ford as a formation rather than as a group. With some adjustment regarding the boundary between the Britton and Arcadia Park, however, the three subdivisions proposed by Moreman might stand as members of this formation.

#### CONCRETIONS

The Eagle Ford contains concretions made of marcasite, ferruginous claystone, and dense gray limestone. Of these the limestone concretions are the largest and most abundant, occurring at various levels from the bottom to the top of the formation and becoming relatively more abundant toward the top. (See Shuler, 1918, p. 17-18, Pls. 3, 4.) The iron-claystone concretions are most abundant in the shales below the level of the flaggy limestone ledges exposed at Arcadia Park. Marcasite forms small and inconspicuous nodules, seldom exceeding 2 inches in length, which seem to be most common in the middle and lower parts of the formation.

There are two main types of limestone concretions. One is lenticular, several times longer and wider than thick; the other is ellipsoidal. Concretions of the first type lie with their longer dimensions parallel with the bedding of the surrounding shale, and may show internal lamination which is likewise parallel with the general bedding. They are not commonly septarian. Examples may be seen in the shale banks a half mile west of the intersection of Anderson and Mansfield roads. Here the larger limestone bodies range up to 6 feet long and 1 inches thick (Fig. 5). Concretions of this type are evidently syngenetic and in effect small limestone lentils. They are most abundant in the shales below the level of the flaggy limestone ledges seen at Arcadia Park.

Figure 5.—Limestone lentils in Eagle Ford shale, near the intersection of Mansfield and Anderson roads, southern Dallas County.

Ellipsoidal calcareous concretions abound in the upper part of the formation, where large examples weighing a hundred or more pounds are not uncommon. Such concretions are well displayed in the railway cut just west of Chalk Hill on the Dallas-Fort Worth highway. Here they are of dense gray limestone. Their long axes range in length between an inch and three feet, and the planes including the long and intermediate axes lie roughly parallel with the bedding. The concretions tend to be concentrated along certain surfaces of stratification, although there is no apparent regularity in their spacing at any level. In detail the surfaces of the larger concretions are undulatory. The shaly bedding wraps around these concretions, conforming closely to their superficial irregularities. All of the larger and many of the smaller limestone bodies are septarian, the veins consisting of clear or amber calcite. Where incompletely filled, the cracks are lined with dogtooth spar. Only a few concretions at this locality contain fossils, and these seem to be mostly on their upper surfaces rather than in nuclear positions.

Claystone concretions are abundant in the shales at Keenan's Crossing and in the banks along Elm Fork near the crossing of the Chicago, Rock Island and Pacific railroad. They generally are brownish and iron-stained externally and gray on the inside. Most are only a few inches across, and flattish, with their long and intermediate axes paralleling the bedding. They tend to be concentrated along certain levels, and locally are so closely spaced as to form thin ledges continuous for a score or more feet. Specimens from Keenan's Crossing were mostly unfossiliferous and showed no visible reaction with hydrochloric acid. Some are abundantly fossiliferous, however, and correspondingly calcareous.

Marcasite, perhaps pyrite also, occurs as impregnations in the permineralized portions of fossil bones enclosed in the shales, as replacing material for parts of calcareous shells, as internal casts in foraminiferal tests, and as small encrusting masses or concretions. Marcasite nodules up to 3 inches across may be found in small gullies in the Eagle Ford along the west side of Elm Fork floodplain opposite Carrollton. These nodules are mammillary and have relatively smooth surfaces with no large or well-developed crystals.

### SELENITE

Selenite crystals are common in most parts of the shale. The crystals may be exceedingly small, almost microscopic, and gathered in lustrous clusters along bedding surfaces; they may form single or twinned, tabular or lenticular individuals up to 3 inches long and a half inch thick; or they may occur intergrown in small veins which are generally a fraction of an inch across, and which may lie parallel with or across the bedding. Most of the selenite is clear, but some is amber. The larger crystals enclose shale particles—one of several lines of evidence to indicate that they formed after the shale had been deposited. As suggested elsewhere in this report, the selenite may owe its origin indirectly to the decomposition of marcasite.

### WEATHERING

Where observed in fresh cuts, the upper portion of a shale bank is generally brownish and the lower part is dark gray. The brownish color, as Ries (1908, p. 189) has explained, is due to weathering. At the 60-foot section of shale exposed west of the intersection of Mansfield and Anderson roads this discoloration extends down 25 feet below the surface.

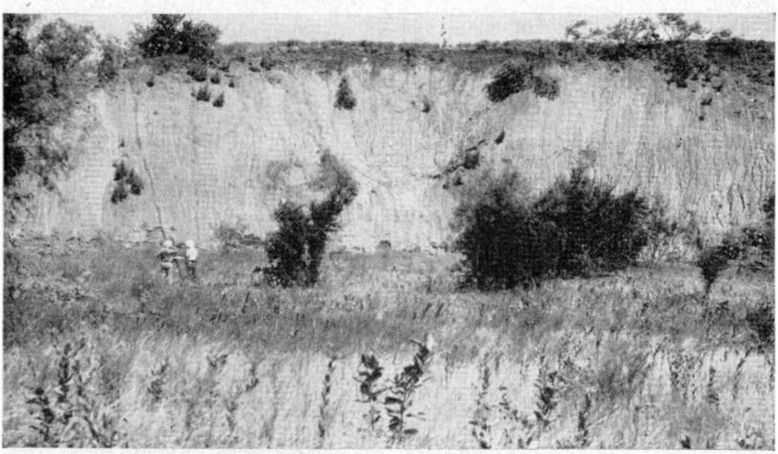


Figure 6.—Undercut bank in Eagle Ford shale, near the intersection of Mansfield and Anderson roads, southern Dallas County. Ampitheater-like depression below man holding stadia rod is due to slumping.

When moistened the shale distintegrates into a highly plastic mass consisting of clay particles enclosing small chips or scales of shale. A single drenching rain will cause the surface of fresh shale exposures to become more or less uniformly covered with this sticky paste, which upon drying develops mud-cracks. Most all, including the steepest, shale banks are plastered with this mud-cracked film, which may be destroyed and reformed in the course of a single downpour.

The plasticity of the moistened shale makes it particularly susceptible to mass-wasting by slumping. Slumped blocks may be seen at nearly every undercut bank, and recurrence of slumping tends at once to waste the shale banks rapidly and to maintain their steepness of slope (Fig. 6).

### FOSSILS

More so than in the younger formations of the Gulf Series, the fossils of the Eagle Ford seem to be crowded at certain levels and uncommon or lacking in between. The forms reported include marine invertebrates and vertebrates belonging to a variety of classes.

The microfauna is dominated by Foraminifera and ostracods, but these do not appear to be nearly so abundant or diversified as those of the Austin and Taylor formations. Foraminifera are represented in greatest numbers by thin-shelled calcareous tests of which *Globigerina* and *Guembelina* are perhaps most abundant. Although H. J. Plummer's check list of Foraminifera from six localities in Dallas and Denton counties (Adkins, 1932, p. 438) incluudes several arenaceous forms, these do not appear to be very common, except possibly in the lower part of the formation.

Corals are rare, although small coral heads, as yet undescribed, occur in the upper shales near Arcadia Park. Worm tubes are occasionally found, as are echinoid fragments. The molluscs, however, are by far the most abundant. Small gastropods abound in the upper shales near Chalk Hill. Pelecypods, *Inoceramus* and *Alectryonia* notably, occur at many levels and locally form thin shelly layers. Prisms from disintegrated shells of *Inoceramus* are common in the finer concentrates. More than 25 different species of ammonites have been collected and described, and a number of these have type localities within the county.

Crustacea are abundant at a few localities. Dr. H. B. Stenzel has kindly supplied information on several of his species together with the illustrative matter included with this report.

Fish teeth and bones are to be picked up by the hands-full at several localities, and the bones of large sea-reptiles such as *Elasmosaurus* are occasionally found.

The larger fossils of the Eagle Ford as well as the micro-fossils are generally in an excellent state of preservation. Shells of ammonites and pelecypods commonly retain their pearly luster, a fact that has made the Eagle Ford a favored formation among collectors of fossils.

The following annotated check list indicates the species which have been reported from Dallas County. The list, obviously incomplete, emphasizes the need for further work on the Eagle Ford fauna in the type area.

**Foraminifera**

*Gaudryina filiformis* Berthelin; Moreman, 1927, p. 99, Pl. 16, fig. 8. Moreman reports this species from the Eagle Ford six miles northwest of Irving.

*Nodosaria communis* (d'Orbigny); Moreman, 1927, p. 99, Pl. 16, fig. 5. Moreman reports this species from the Eagle Ford six miles northwest of Irving.

*Robulus cultratus* Montfort; Moreman, 1927, p. 99, Pl. 16, figs. 6, 7. Moreman reports this species from the Eagle Ford six miles northwest of Irving.

*Guembelina globulosa* (Ehrenberg); Moreman, 1927, p. 99, Pl. 16, fig. 10. This species was reported by Moreman from the Eagle Ford six miles northwest of Irving.

*Quinqueloculina stelligera* Schlumberger; Moreman, 1927, p. 100, Pl. 16, figs. 11, 12. Moreman reports this species from the Eagle Ford six miles northwest of Irving.

*Globigerina cretacea* d'Orbigny; Moreman, 1927, p. 100, Pl. 16, figs. 14, 15. This species was reported by Moreman from the Eagle Ford six miles northwest of Irving.

#### Corals

*Isastrea discoidea* White; Hill, 1889-a, p. 7; 1889-b, p. 1. Hill states that he has found corals in the shales at Eagle Ford that probably belong to this species.

#### Worms

Worm tubes have been reported by Stenzel (1941) from a locality three and one-half miles west of Cedar Hill.

#### Gastropods

? *Actaeon* sp.; Stenzel, 1941. A gastropod cast collected from a locality three and one-half miles west of Irving is questionably referred to this genus by Stenzel.

? *Natica* sp.; Stenzel, 1941. A gastropod cast collected from a locality three and one-half miles west of Cedar Hill is questionably referred to this genus by Stenzel. Naticoid gastropods have also been reported by Stenzel (1941) from the Britton member of the Eagle Ford at the crossing of the Chicago Rock Island and Pacific railroad over Elm Fork.

? *Cerithium* sp. indet. Stenzel (1941) reports cerithiid gastropods from the Britton member of the Eagle Ford at the crossing of the Chicago Rock Island and Pacific railroad over Elm Fork.

#### Pelecypods

*Alectryonia lugubris* (Conrad); Adkins, 1932, p. 426, 429; Adkins, 1928, p. 104, Pl. 16, fig. 5, Pl. 24, figs. 8, 9. Shells belonging to this species range through the upper 50 to 75 feet of the Eagle Ford in the Arcadia Park area, and are most abundant in the upper 15 feet.

*Inoceramus dimidius* White; Adkins, 1932, p. 426. Reported from the lower flaggy layers of the Arcadia Park member of the Eagle Ford, where it is associated with *Prionotropis* aff. *woolgari* (Mantell).

*Inoceramus fragilis* Hall and Meek; Stenzel, 1941. This species was reported from the Britton member of the Eagle Ford at the crossing of the Chicago Rock Island and Pacific railroad over Elm Fork.

#### Echinoids

Echinoid, indet.—Reported by Stenzel (1941) from the Britton member of the Eagle Ford formation at the crossing of the Chicago Rock Island and Pacific railroad over Elm Fork.

**Ammonites**

*Exiteloceras angulatum* Meek; Hyatt, 1894, p. 577; Adkins, 1928, p. 212. This species has been reported from Elm Fork, Dallas County. Presumably it is from the Eagle Ford.

*Exiteloceras pariense* (White); Moreman, 1927, p. 95, Pl. 14, fig. 3; Adkins, 1928, p. 212, Pl. 26, fig. 3. Moreman states that this species is common in the Eagle Ford at localities in Dallas and Denton counties, but makes no reference to specific localities. For a discussion of this species see Scott (1926, p. 152-153).

*Ancyloceras* (?) *annulatum* Shumard; Adkins (1928, p. 216) states that the generic position of this ammonite is uncertain. Cummins collected specimens from clay-ironstone concretions along Hackberry Creek, and Leverett found specimens in "dove-colored shale at Eagle Ford of the Trinity River" which Cragin (1893, p. 324) referred to Shumard's species, emending the genus to *Crioceras*. Stenzel (1941) reports the species from the Britton member of the Eagle Ford at the crossing of the Chicago Rock Island and Pacific railroad over Elm Fork, and refers it to *Allocrioceras*.

*Eucalycoceras bentonianum* (Cragin). This form was originally described as "*Pulchellia bentonianum*" by Cragin (1893, p. 239-240). Cummins collected the types from clay-ironstone concretions in the Eagle Ford exposed along Hackberry Creek. Adkins (1932, p. 433) has reported the species from the same locality. Stenzel (1941) reports a species of *Eucalycoceras*, which may not be the same as the one listed here, from the Britton member of the Eagle Ford exposed in the right bank of Elm Fork near the bridge of the Chicago Rock Island and Pacific railroad.

*Neocardioceras septem-seriatim* (Cragin). Evidently this species has been described under several different names. Cragin (1893, p. 240) originally designated this form as "*Scaphites septem-seriatus*". The types were collected by Cummins from an iron-claystone concretion in the Eagle Ford shale at Keenan's crossing of the Trinity River. Moreman (1927, p. 95, Pl. 15, fig. 5) described and figured Eagle Ford ammonites under the name "*Acanthoceras kanabense*" which Adkins (1931, p. 60-63) placed in synonomy with Cragin's species. The generic name, *Neocardioceras*, was applied by Adkins in a supplementary note following his paper on Upper Cretaceous ammonites in western Texas (1931, p. 72). Stenzel (1941) reports this species from an exposure of the Britton member of the Eagle Ford near the bridge of the Chicago Rock Island and Pacific railroad over Elm Fork.

*Coilopoceras eaglefordense* Adkins (?); Adkins, 1931, p. 46-48, 50, Pl. 4, figs. 4, 8; Pl. 5, fig. 1. An ammonite found in a creek running parallel to the White Rock escarpment at a point about 5 miles south of the Fort Worth-Dallas highway was reported by Professor J. M. Barcus to be similar in form and size to this species. The horizon from which the fossil was collected was estimated to lie about 100 feet below the top of the Eagle Ford formation.

*Borissiakoceras* sp.; Adkins, 1932, p. 433. A species regarded as new by Adkins has been reported by that writer from the Eagle Ford along Cottonwood and Walnut Creeks, exact localities not indicated.

*Metoicoceras acceleratum* Hyatt; Hyatt, 1903, p. 127-128, Pl. 14, figs. 11-14. The type locality is given as "Elm Fork, Hortons Mill, Dallas County".

*Metoicoceras gibbosum* Hyatt; Hyatt, 1903, p. 121, Pl. 15, figs. 5-8; Moreman, 1927, Pl. 14, fig. 4. Moreman states that Hyatt's species is especially abundant at exposures west and southwest of Dallas, but does not indicate any specific localities.

*Metoicoceras irwini* Moreman; Moreman, 1927, p. 92, 94, Pl. 13, figs. 3, 4. Specimens were found by Moreman 6 miles northwest of Irving near the Irving-Coppell Road where a small creek that runs toward the Elm Fork has exposed the Eagle Ford shales. Presumably this is the type locality. On the generalized section accompanying Moreman's report this species is shown to occur about 200 feet above the base of the formation.

*Metoicoceras whitei* Hyatt; Hyatt, 1903, p. 122-127, Pl. 13, figs. 3-5. Pl. 14, figs. 1-10, 15; Scott, 1926, p. 142-143. The type locality for this species is given as "Elm Fork, Horton's Mill, Dallas County". Stenzel (1941) has reported it from the Britton member of the Eagle Ford at the crossing of the Chicago Rock Island and Pacific railroad over Elm Fork. Moreman (1927, p. 94) considers this one of the most abundant species in the Eagle Ford.

*Metoicoceras swallovi* (Shumard); Adkins, 1932, p. 429. This species is reported from concretions in the upper Eagle Ford along the White Rock escarpment southwest of Dallas. It is not certain that the form described by Cragin (1893, p. 234) as "*Buchiceras swallovi Shumard*" belongs to this species. Cragin indicated that his specimens came from Dallas County, but did not specify any particular localities.

*Prionotropis graysonensis* (Shumard) Adkins, 1928, p. 249-25. This species has been reported from the upper Eagle Ford at Arcadia Park.

*Prionotropis* aff. *woolgari* (Mantell); Moreman, 19227, p. 97, Pl. 13, fig. 2; Adkins, 1932, p. 426, 433; Scott, 1933, p. 56-58. This small ammonite is characteristic of the lower portion of the Arcadia Park shales (upper Eagle Ford) and is particularly abundant in the flaggy layers about 20 feet above the base of the Arcadia Park member.

*Prionocyclus* sp. Adkins (1932, p. 426) reports this genus from the upper part of the Arcadia Park shale member of the Eagle Ford, in the area of Arcadia Park.

*Proplacenticeras syrtale* var. *cumminsi* (Cragin); Cragin, 1893, p. 237-239; Adkins, 1932, p. 429, 433. This variety, originally assigned by Cragin to *Placenticeras*, was based on a single specimen collected by Cummins from clay-ironstone concretions along Hackberry Creek. Adkins states that it occurs in the upper Eagle Ford, in concretions containing *Metoicoceras swallovi* and other ammonites. It has also been collected frm horizins between 160 and 250 feet above the base of the formation. Stenzel (1941) reports *Proplacenticeras* from the Britton member of the Eagle Ford at the crossing of the Chicago Rock Island and Pacific railroad over Elm Fork, but the species has not been determined.

*Placenticeras pseudoplacenta* var. *occidentale* Hyatt; Hyatt, 1903, p. 217-220, Pl. 45, figs. 1, 2. The types are from "Elm Fork, Dallas County". For a discussion of the species see Scott (1926, p. 143-144).

*Placenticeras stantoni* var. *bolli* Hyatt; Hyatt, 1903, p. 214-216, Pl. 40, figs. 3-7; Pl. 41; Pl. 42; Pl. 43, figs. 1, 2. The specimens described by Hyatt are stated to have come from "Elm Fork and West Fork, Dallas County and Tarrant County, Texas".

*Scaphites vermiculus* Shumard; Adkins, 1932, p. 433, reports this species from the zone of *Prionotropis* in the upper Eagle Ford around Arcadia Park. The generic position is uncertain (Adkins, 1928, p. 259-260). Stenzel (1941) has reported the species, under the name *Worthoceras*, from the right bank of Elm Fork near the bridge of the Chicago Rock Island and Pacific railroad.

*Baculites annulatus* Conrad; Conrad, 1855, p. 265. In Conrad's account of this species there is no mention of a specific type locality or stratigraphic horizon, nor are the types figured. Adkins (1928, p. 206) incorrectly lists the species as one of Shumard's. It is probable that the species belongs to the Eagle Ford, as *Baculites* is more common in this formation than in any other within the county.

*Baculites gracilis* Shumard; Cragin, 1893, p. 237-239, stated that this species was found in iron-claystone concretions of the Eagle Ford along Hackberry Creek. This report was later confirmed by Adkins (1932, p. 433). Stenzel (personal communication dated Nov. 24, 1941) reports finding this species at the crossing of the Chicago, Rock

Island and Pacific over Elm Fork. For a discussion of the species see Scott (1926, p. 153-154).

*Hamites larvatus* Conrad; Conrad, 1855, p. 265-266. Beyond the fact that the type for this species came from Dallas County, nothing is known regarding its occurrence. Granting that the specimen on which the species was founded came from one of the three Cretaceous formations in the county and not from reworked materials in Cenozoic alluvium, it is more likely that the type locality is in the Eagle Ford than in the Austin or Taylor.

*Hamites rotundatus* Conrad; Conrad, 1855, p. 266. The same remarks given above for *H. larvatus* apply to this species.

*Protengonoceras planum* Hyatt; Hyatt, 1903, p. 156-157, Pl. 18, figs. 6-9. The horizon and locality of the types are unknown. Hyatt states that the matrix is similar to that of the Eagle Ford of Horton's Mill, Dallas County.

*Metengonoceras acutum* Hyatt; Hyatt, 1903, p. 184-185, Pl. 26, fig. 8; Pl. 27, figs. 1, 2. The specimens described by Hyatt came in part from "Elm Fork and West Fork (Horton's mill)", Dallas County.

*Metengonoceras dumbli* (Cragin); Cragin (1893, p. 243-244, Pl. 44, fig. 6) originally described this species as "*Sphenodiscus dumbli.*" Hyatt (1903, p. 185, Pl. 27, figs. 3-14) changed the generic name to *Metengonoceras*, and suubsequently the species has been variously assigned to *Engonoceras, Epengonoceras*, and *Metengonoceras*. (Adkins, 1928, p. 264). The types were found in clay ironstone concretions along Hackberry Creek and at Keenan's Crossing, Dallas County.

**Ostracods**

*Cytherella muensteri* (Roemer); Alexander, 1929, p. 50, Pl. 1, figs. 9, 10. This species was reported by Alexander from his Station 40. (See geologic map.) It is thought to be restricted to the Eagle Ford.

*Bairdia subdeltoidea* (Muenster); Alexander, 1929, p. 61-62, Pl. 3, fig. 5. This species was reported by Alexander from his Sttaion 40. (See geologic map.) It has been found only in the Eagle Ford.

*Cythere cornuta* var. *gulfensis* Alexander; Alexander, 1929, p. 85-86, Pl. 8, figs. 1, 2, 6. This species was reported from the Eagle Ford by Alexander (Stations 40, 41—See geologic map.). It is rare in the Eagle Ford, ranging throughout the Upper Cretaceous of north Texas, and most common in the Taylor.

*Cythereis eaglefordensis* Alexander; Alexander, 1929, p. 98, Pl. 9, figs. 9, 12. According to Alexander this species has been found only in the Eagle Ford, in the zones of *Metoicoceras irwini* Moreman and *M. whitei* Hyatt. Type locality: Alexander's station 40. (See geologic map.)

**Crustaceans**

*Linuparus grimmeri* Stenzel, Stenzel, 1941. This species is reported from the right bank of Elm Fork upstream from and at the Chicago Rock Island and Pacific railroad bridge, in the Britton member of the Eagle Ford.

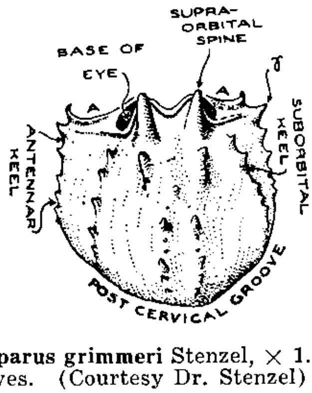



Figure 7.—**Linuparus grimmeri** Stenzel, × 1.5. Carapace anterior to the cervical grooves. (Courtesy Dr. Stenzel)

*Linuparus watkinsi* Stenzel; Stenzel, 1941. Same locality as above. (Fig. 8)

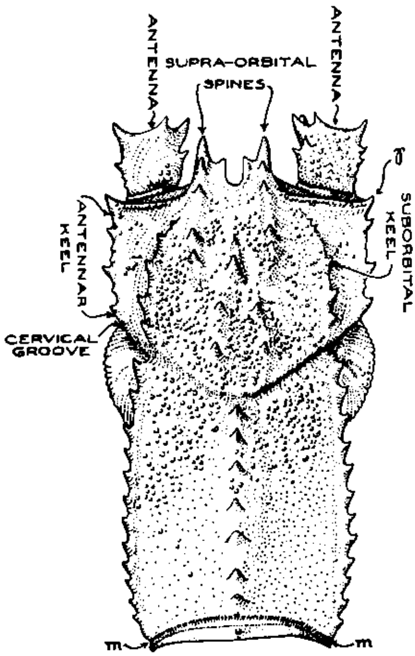



Figure 8.—**Linuparus watkinsi** Stenzel, × 1.5. **Carapace and part** of antennae. (Courtesy Dr. Stenzel)

*Homarus brittonestris* Stenzel; Stenzel, 1941. Same locality as above. (Fig. 9)

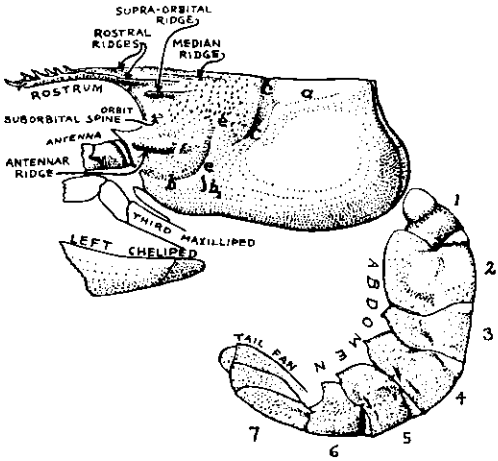



Figure 9.—**Homarus brittonestris** Stenzel, × 1.5. Composite of several specimens. (Courtesy Dr. Stenzel)

*Notopocorystes dichrous* Stenzel; Stenzel, 1941. Same locality as above. (Fig. 10)

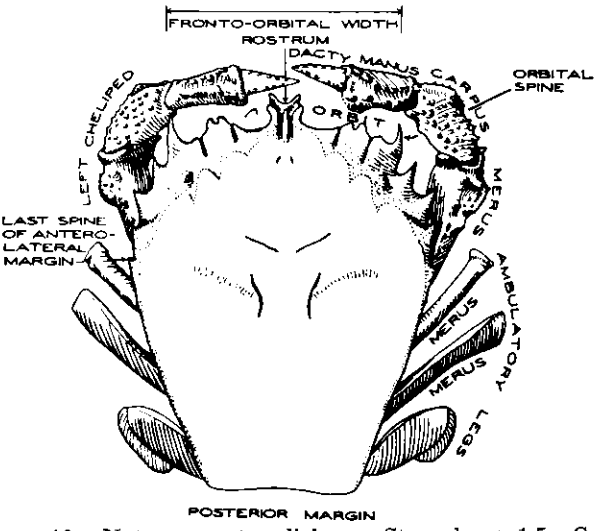



Figure 10.—**Notopocorystes dichrous** Stenzel, × 1.5. Composite of several specimens; complete animal except for the eyes, abdomen, last legs, and parts of the other ambulatory legs. (Courtesy Dr. Stenzel)

*Upogebia rhacheochir* Stenzel; Stenzel, 1941. Same locality as above. (Fig. 11)

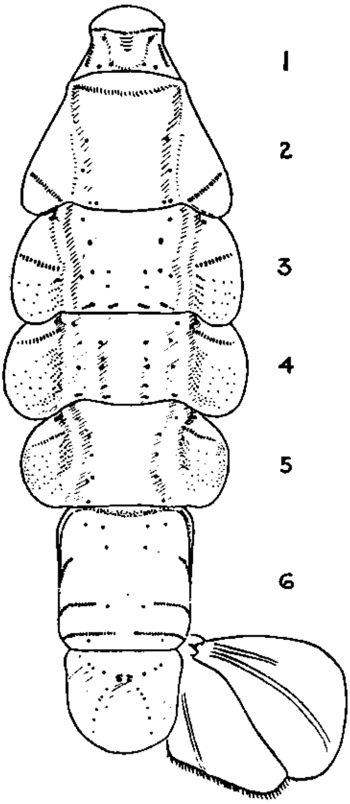



Figure 11.—**Upogebia rhacheochir** Stenzel, × 3. Abdomen. (Courtesy Dr. Stenzel)

*Necrocarcinus ovalis* Stenzel; Stenzel, 1941. This species is reported by Stenzel from a locality three and one-half miles west of Cedar Hill. (Fig. 12)

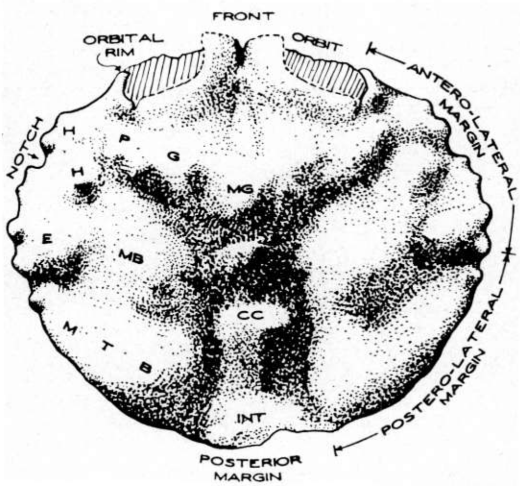



Figure 12.—**Necrocarcinus ovalis** Stenzel, × 4.5. Carapace. CC-cardiac; E-epibranchial; H-hepatic; INT-intestinal; MB-mesobranchial; MG-mesogastric; MTB-metabranchial; PG-progastric. (Courtesy Dr. Stenzel)

*Cenomanocarcinus vanstraeleni* Stenzel; Stenzel, 1941. Same locality as for *Linuparus grimmeri.*

**Vertebrates**

*Ptychodus* cf. *whippleyi* Marcou; Stenzel, 1941. Remains of this large Cretaceous skate are reported by Stenzel from a locality three and one-half miles west of Cedar Hill.

*Clidastes* sp.; Stenzel, 1941. Lower jaw fragments of this mososaur are reported by Stenzel from a locality three and one-half miles west of Cedar Hill.

*Elasmosaurus* sp. (Fig. 13) An interesting and as yet undescribed specimen of a large sea-reptile belonging to this genus was found on the Jack Anderson farm west of Cedar Hill in shales estimated to be about 50 feet below the top of the Eagle Ford. The parts recovered include the head, 59 cervical vertebrae, 12 dorsal vertebrae, the complete pectoral girdle, most of the two front paddles, numerous ribs, and gastroliths. The head is 22 inches long, the neck 18 feet. Total length of the specimen is 25 feet, and the estimated restored length is 37 feet. The head and part of the neck are on display in a show case on the second floor of Hyer Hall, Southern Methodist University.

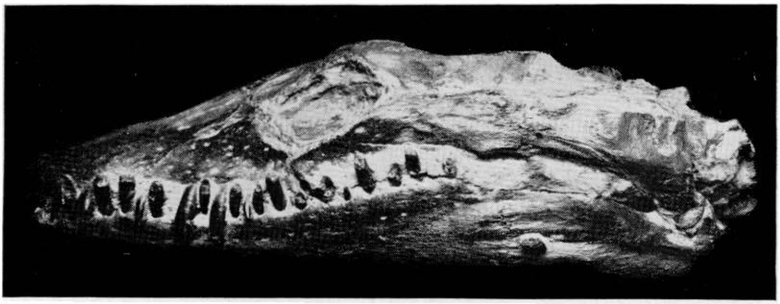


Figure 13.—Head of **Elasmosaurus**, from Eagle Ford formation. (Courtesy Dr. Shuler)

## ZONATION

Adkins (1932, p. 433, 435) has propcsed the following tentative zonation of the Eagle Ford in the Dallas County area.

| | | Feet |
|---|---|---|
| 8. | *Alectryonia lugubris* zone: shale with sand, shells, bones, fish teeth, and *A. lugubris* (Conrad) in abundance; White Rock escarpment | 15 |
| 7. | *Prionotropis* zone: shale and thin flaggy limestone; *Prionotropis, Prionocyclus, Scaphites vermiculus* Shumard; Arcadia Park | 60 |
| 6. | *Coilopoceras zone:* shales; *C.* aff. *eaglefordense;* about | 75 |
| 5. | *Romaniceras-Metoicoceras whitei* zone | 50 |
| 4. | *Neocardioceras* zone: shales; Keenan's Crossing (*N. septem-seriatim, Metengonoceras dumbli*), Horton's Mill, California Crossing; thickness uncertain, possibly | 50 |
| 3. | *Eucalycoceras bentonianum-Borissiakoceras* zone: shales; *Borissiakoceras* n. sp., *Metoicoceras irwini* (Cottonwood Creek); *Borissiakoceras* n. sp., *Eucalycoceras* n. sp. (Walnut Creek); *Eucalycoceras bentonianum* (Cragin), *Metengonoceras dumbli* | |

(Cragin), *Proplacenticeras syrtale* var. *cumminsi* (Cragin), *Baculites gracilis* Shumard, "*Ancyloceras*" *annulatum* Shumard, *Inoceramus* (Hackberry Creek); about ........................ 90

2. *Acanthoceras* (*Eucalycoceras?*) *wintoni* zone: carbonaceous shales; *Ammonites inequiplicatus* Shumard; about ............................145

1. *Acanthoceras tarrantense* zone: shale, sandstone; Tarrant station; about ...................... 15

CONDITIONS OF ORIGIN

That the dark muds which now represent the Eagle Ford were originally deposited in marine waters is indicated by the remains of typical marine organisms, such as Foraminifera and ammonites, which occur at intervals from the bottom to the top of the formation. Scott (1940, p. 322) suggests that the muds were deposited in the infra-neritic zone; that is, in waters deeper than 120 feet but not more than 600 feet deep.

Twenhofel has listed eight characteristics of black shales in general. These are: (1) they are commonly thinly-laminated, indicating that accumulation was slow and largely from fine materials in suspension, (2) they contain delicate parts of organisms in excellent state of preservation, indicating that a scavenger population was largely lacking, (3) burrows of mud-eating organisms are usually rare or wanting, (4) the most abundant fossils are planktonic or epiplanktonic, and usually of considerable geographic range, (5) fossils are rare in many layers, abundant in others, (6) benthonic forms are rare, and restricted to a few horizons, (7) they contain pyrite and marcasite, and (8) they contain beds of sandstone and sandy shale scattered through at intervals.

With the possible exception of number 4, these characteristics hold for the Eagle Ford. Twenhofel attributes the retention of the dark organic coloring matter in black muds to the general absence of scavenging and decomposing organisms, which otherwise would destroy the organic material as it accumulated. Conditions that inhibit the work of these organisms obtain in waters that are deficient in oxygen, due to limited or no circulation.

Granting that the Eagle Ford muds were deposited mostly in stagnant oxygen-deficient salt water, it remains for future investigators to decide on the nature and limits of the basin that received these sediments and how it was related to the rest of the country that was flooded by the late Cretaceous seas.

## AUSTIN FORMATION

### TYPE LOCALITY AND THICKNESS

The Austin was named by B. F. Shumard in 1860 for limestone beds exposed in and around the capitol city of the state. The formation has gone by several names, and in the early writings of Hill it was variously called the "Rotten limestone", the "Dallas limestone", or the "Austin-Dallas chalk". Once it was established that the beds at Austin and Dallas belonged to the same formation, which could be traced along the surface between the two cities, Shumard's designation was adopted and the other names fell into disuse.

The Austin is approximately 600 feet thick in Dallas County. This is near its maximum thickness along the outcrop (Stephenson, 1937, p. 135, Fig. 7).

### OUTCROPS

Because of its superior hardness and resistance to erosion the Austin crops out over a relatively larger area than either the Eagle Ford or the Taylor. Outcrops are so abundant that the county soil-survey map has a special symbol to show the larger ones; and according to this map, the Austin shows at the surface over 2.6% of the county (Carter, *et al.*, 1924, p. 1227). The formation is exposed in the banks of nearly every stream that crosses it. Good sections are to be found along highway and railway cuts. Numerous quarries have been opened in the Austin, and these afford excellent sections for study. The best natural exposures are along the south side of the Trinity Valley, and along White Rock Escarpment south of the river, where limestone ledges show at the surface for many miles. In spite of good exposures and lack of major structural complications, however, there has been relatively little accomplished in the way of detailed stratigraphic work.

#### LITHOLOGY AND CHEMICAL COMPOSITION

In Dallas County the Austin formation may be divided into four parts, as indicated below. Figures for thickness are approximate.

*Taylor formation*

*Disconformity* (?)

*Austin formation*

| | Thickness (Feet) |
|---|---|
| 4. Chalk with interbedded thin layers of marl and calcareous shale. | 180 |
| 3. Marl and calcareous shale with interbedded thin strata of chalk. | 220 |
| 2. Chalk with interbedded thin layers of marl and calcareous shale. | 200 |
| 1. Pebbly marl or chalk containing materials reworked from the Eagle Ford. Maximum thickness observed: | 4 |

*Disconformity*

*Eagle Ford formation*

Further study may warrant assigning names to these members, but in this report they will be called the upper chalk, middle marl, lower chalk, and basal pebbly beds.

The basal pebbly beds are well exposed along Lake View and Keller Springs roads, respectively south and north of the Trinity River at the localities marked "Good exposure of Austin-Eagle Ford contact" on the geologic map (Pl. 1). The basal member is four feet thick at the first locality, two feet thick at the second. At both places it consists of gray to buff-weathering gritty and pebbly marl, the visible constituents consisting of fish teeth, fish vertebrae, and dark internal molds of gastropods and pelecypods. These fossils are most abundant along the base where they form thin conglomeratic lentils in places. The marl grades upward into chalk, which is more or less shaly along Keller Springs road.

At the Trinity Portland cement quarry, the basal bed of the Austin is less than a foot thick, and consists of gray impure pebbly chalk. In addition to internal molds of gastropods and pelecypods this bed contains at its base round chalk cobbles up to five inches across, and septarian concretions of about the same size. The latter are similar to concretions in the upper Eagle Ford, and it is probable that they represent material reworked from that formation.

The lower chalk member consists of chalk beds alternating with thinner layers of marl and calcareous shale (Fig. 18). The chalk beds range in thickness from less than a foot to six feet, averaging about two feet. Marly and shaly partings are generally only an inch or so thick. Where freshly quarried or brought up in well cuttings the chalk is soft, with a gray color and earthy luster. On drying it becomes harder and bleaches white. Some of the strata fracture subconchoidally, and are durable enough for road metal or building stone. Even the hardest beds, however, may be rather easily cut with a hand saw or knife.

According to Adkins (1932, p. 446) the chalk shows in thin sections to have the typical crystalline structure of limestone, and to be made of calcite crystals, particles of amorphous calcareous matter, and whole shells or fragments of Foraminifera, pelecypods, gastropods, and echinoids.

Taff (1913, p. 336) has published an average analysis of the lower 20 feet of white chalk at the Texas Portland Cement works, and according to his data the chalk consists predominantly of calcium carbonate (70.21%) and of silica and insolubles which together amount to 23.55%. Ferric oxide and alumina account for 1.5% of average samples, and magnesium carbonate is a minor constituent (0.58%).

The middle marl consists of powdery gray to buff calcareous rock which generally shows fine lamination and shaly parting. It contains interbedded chalk layers up to two feet thick that are similar to the chalk of the lower member. The marl is softer than the chalky beds between which it is sandwiched, and its outcrop north of the Trinity is approximately marked by the valley of White Rock Creek.

Good exposures may be seen around White Rock Lake, particularly on the east side. Concentrates of samples collected in this area are made largely of Foraminifera, ostracods, and shell fragments of larger fossils.

Figure 14.—Lenticular beds in upper Austin formation exposed in quarry on State Highway 183.

The upper chalk member is lithologically similar to the lower. Good exposures are to be seen west of Pleasant Mound Church on State Highway 183. In the small quarry on the north side of the highway 0.8 mile west of the church the bedding of the chalk is markedly lenticular (Fig. 14).

#### CONCRETIONS

Marcasite concretions are scattered throughout the Austin, but they seem to be most common in the gray marly shales. They range from a fraction of an inch up to three inches in diameter. The larger ones tend to be ellipsoidal or cylindric, lying with their longer dimensions paralleling the bedding. Shapes of smaller individuals reflect the form of the dominant crystal faces developed on them. The surfaces are set with well-formed crystals in spear or cockscomb-shaped groups. Sections reveal radial structures inside the larger examples.

Although these concretionary bodies have often been called pyrite in the literature, it is probable that most if not all are marcasite. This is indicated by the pale yellow color seen on fresh fractures, the characteristic cockscomb habit of the crystals, and by the fact that powdered samples release free sulphur when treated with cold nitric acid. Some specimens have a golden-brown tarnish, and it is probably due to this that they have been identified as pyrite.

On exposure the concretions alter readily to limonite, the brown stains of which are to be seen on nearly every chalk outcrop. Fresh specimens are found only in artificial exposures or on steep slopes where the marly shale is eroding rapidly. A locality that has supplied many beautiful specimens is at Flagpole Hill near the north end of White Rock Lake.

### FOSSILS

Concentrates of marly and shaly specimens are largely made of foraminiferal tests, ostracod shells, calcareous prisms from pelecypod valves, and spines and plates of echinoderms. These materials occur likewise in the massive chalky layers. The formation, indeed, is made in considerable part of such fine-grained material of organic origin.

The Foraminifera and ostracods of the Austin show considerable more diversity than those of the Eagle Ford. Arenaceous and thick calcareous foraminiferal tests are relatively abundant; fragile globigerine and guembeline forms are likewise abundant but do not dominate the microfauna as they do in many parts of the Eagle Ford. Alexander has reported 12 species of octracods, several of which have type localities in the county.

Large thick-shelled exogyrate pelecypods occur in the upper part of the formation. *Gryphaea* and *Inoceramus* are common, the former occurring in such abundance at certain levels as to form thin shelly beds. Some of the pelecypod shells are encrusted with bryozoan remains. Large rudistids, as yet undescribed, are known to occur as isolated individuals or small groups in the middle marly beds. Poorly preserved ammonites and echinoids are occasionally found.

Well-preserved fish of several kinds have been collected from the massive chalky beds.

On the whole the fauna of the Austin chalk in the Dallas area has received little attention from paleontologists, and the following check list casts little light on the relative abundance of the different groups represented.

**Foraminifera**

*Flabellammina rugosa* Alexander and Smith; Alexander and Smith, 1932, p. 302-303, Pl. 45, figs. 8, 9. Paratypes figured in this paper are from Alexander's station 42.

*Dorothia bulletta* (Carsey); H. J. Plummer, 1931, p. 133. Plummer reports this species from the Austin chalk on the Dallas-Greenville highway southeast of White Rock Lake.

*Pseudogaudryinella mollis* (Cushman); Cushman, 1933, p. 53, Pl. 6, figs. 6a-c; 1937-a, p. 140, Pl. 19, fig. 17. Originally described as a *Gaudryinella*, the species was later referred to *Pseudogaudryinella* by Cushman. The type locality is 2.3 miles north of Dallas on the Dallas-Sherman highway (C. I. Alexander, collector).

*Frondicularia undulosa* Cushman; Cushman, 1936, p. 13, Pl. 3, figs. 7-11. The type locality for this species is in the Austin chalk 2.3 miles north of Dallas on the Dallas-Sherman highway.

*Rectoguembelina hispidula* Cushman, 1938-a, p. 21, Pl. 3, figs. 20-22. The type locality for this species is in the middle Austin chalk at a road cut in the north side of the west Dallas pike, 5.3 miles northeast of the Austin-Eagle Ford contact at Chalk Hill.

*Planulina austinana* Cushman; Cushman, 1938-c, p. 68-69, Pl. 12, fig. 2. The type locality for this species is a road cut on the south side of U. S. Highway 80, 2 feet above the sidewalk opposite the Catholic School, 3.8 miles west of Union Station, Dallas. This species is thought to be restricted to the Austin formation.

**Pelecypods**

*Gryphaea aucella* Roemer, Stephenson, 1936, p. 1-2. This species is found at the same localities described for *G.*

*wratheri*. Stephenson suggests that *G. wratheri* may be a variant of *G. aucella*.

*Gryphaea wratheri* Stephenson; Stephenson, 1936, p. 2-4. Pl. 1, figs. 1-4. The type locality for this species is in a "cut in Gaston Avenue (U. S. Highway 67), just northeast of the intersection of West Shore Drive, 0.7 mile west of the dam of White Rock Reservoir." It is also reported from a hill south of the Orphans Home road, 0.45 mile west of White Rock Creek, at the eastern edge of Dallas.

*Pycnodonta vesicularis* (Lamarck); Hill, 1889-a, p. 11; 1889-b, p. 5; Adkins, 1928, p. 109. This is a doubtful record. Hill reports *"Gryphaea" vesicularis* from the Austin, Taylor, and Navarro of Dallas and Travis counties. There is no mention of specific localities or horizons, however, and it may be that Hill had in mind some other of the grypheate forms that are today recognized in the Auustin.

*Exogyra ponderosa* Roemer; Stephenson, 1923, p. 165-171, Pl. 45, figs. 6, 7; Pl. 46. Stephenson has reported this species from exposures of the Austin chalk along the Dallas road 2.25 miles southwest of Arnold.

*Exogyra ponderosa* var. *erraticostata* Stephenson; Stephenson, 1923, p. 171-173, Pl. 47, fig. 1. This variety of the large *Exogyra* is reported from the Austin chalk seven miles northeast of Dallas.

*Ostrea plumosa* Morton; Stephenson, 1923, p. 147-154, Pl. 38, figs. 14-17, Pl. 39, figs. 11-15. According to Stephenson this pelecypod occurs in the lower part of the *Exogyra ponderosa* zone at exposures of the Austin formation along Prairie Creek, 1.5 miles south of Arnold.

*Inoceramus undulato-plicatus* Roemer; Stephenson, 1937, p. 138. This large pelecypod is abundant in the chalk exposed just below the dam of White Rock Lake.

**Ostracods**

*Cytherella parallela* (Reuss); Alexander, 1929, p. 50-51, Pl. 1, figs. 13, 16. This species has been reported at Alexander's stations 42, 43, and 44. It is rare in the upper portion of the Austin formation, but it ranges up into the Taylor marl, in which it is common.

*Cytherella bullata* Alexander; Alexander, 1929, p. 51, Pl. 1, Figs. 3, 6; p. 51-52, Pl. 2, figs. 4, 6. This species includes the two forms described in the above reference as *Cytherella obesa* Alexander and *C. austinensis* Alexander. The author later discovered that these are dimorphic forms of a single species, of which *obesa* is the female and *austinensis* the male (Alexander, 1932-a). The specific name, *obesa*, however, was preoccupied, so the name was changed to *bullata* (Alexander, 1932-b). The species is fairly common in the upper Austin; it has been reported from Alexander's stations 42, 43, 44, and 45. (See geologic map.) It occurs also in the Taylor. Type locality: station 42.

*Bairdia rotunda* Alexander; Alexander, 1929, p. 62-63, Pl. 3, figs. 2, 6. This species was reported by Alexander from his stations 42, 43, and 44. It is rare in the upper Austin chalk, but is not restricted to the Austin, having been reported from the Taylor at horizons well above the middle of that formation.

*Paracypris pulchella* Alexander; Alexander, 1929, p. 66-67, Pl. 4, figs. 2, 8. Alexander states that this rather rare species has been found only in the upper part of the Austin. It has been reported from Alexander's stations 42, 43, and 44. (See geologic map.) Station 42 is the type locality.

*Krithe cushmani* Alexander; Alexander, 1929, p. 67-68, Pl. 4, figs. 9, 11. Reported to be common at Alexander's stations 42 and 43, and rare at station 44, this species ranges from the upper Austin through approximately the lower two-thirds of the Taylor.

*Cythere semiplicata* (Reuss); Alexander, 1929, p. 80-81, Pl. 6, figs. 9, 15. According to Alexander, this species is abundant at his localities 42 and 43, and common at station 44. It is generally common in the upper Austin, but it ranges up into the Taylor as high as horizons near the top of the Wolfe City sand member of that formation.

*Cythere sphenoides* Reuss; Alexander, 1929, p. 81-82, Pl. 7, figs. 9, 14. This species has about the same range as *C. semiplicata*. Alexander states that it is abundant at his stations 42, 43, 44, and 45. (See geologic map.)

*Cythere foersteriana* (Bosquet) ; Alexander, 1929, p. 82-83, Pl. 6, figs. 1, 11. Alexander found a few specimens belonging to this species at his station 42. The species is rare in the Austin, but fairly abundant in the lower Taylor clays.

*Cythere cornuta* var. *gulfensis* Alexander; Alexander, 1929, p. 85-86, Pl. 8, figs. 1, 2, 6. This species has been reported from Alexander's stations 42, 43, 44, 45, and 46. It occurs throughout the Upper Cretaceous section of north Texas, though nowhere abundantly.

*Cythereis dallasensis* Alexander; Alexander, 1929, p. 99-100, Pl. 7, fig. 7. This species is abundant at Alexander's stations 42 and 43, common at station 44, and rare at 45. It is a "common and characteristic member of the microfauna of the upper part of the Austin chalk in north Texas". Type locality: station 42.

*Cythereis dallasensis* Alexander; Alexander, 1929, p. 99-100, Pl. 8, figs. 8, 9. Common at Alexander's stations 42 and 43, and rare at 44, this species "occurs commonly in the upper part of the Austin chalk and rarely in the lower Taylor formation." Type locality: station 42.

*Cythereis bicornis* Israelsky; Alexander, 1929, p. 100, Pl. 8, figs. 4, 5. This species is characteristic of the lower third of the Taylor formation but it occurs rarely in the Austin, having been reported from Alexander's stations 42, 43, 44, 45, and 46.

### ZONATION

Stephenson (1937) recognizes five faunal zones in the upper one-fourth of the Austin in the type area, Travis County. These are listed below.

5. *Ostrea travisana* zone: about 10 feet below the top of the Austin.

4. *Ostrea centerensis* zone: about 30 feet below the top of the Austin.
3. *Exogyra tigrina* zone: about 40 feet below the top of the Austin.
2. *Gryphaea wratheri* zone: closely above the *Inoceramus undulato-plicatus* zone.
1. *Inoceramus undulato-plicatus* zone: 100 feet or more below the top of the Austin.

Figure 15.—Chalky and marly beds of the Austin formation exposed in the spillway of White Rock Reservoir.

The lower two of these zones have been recognized in Dallas County by Stephenson (1937, p. 138-139). The *Inoceramus undulato-plicatus* zone is well exposed just below the dam of White Rock Lake (Fig. 15). Here the chalky layers are crowded with molds and shell fragments of this large pelecypod. The *Gryphaea wratheri* zone occurs in marly beds a few tens of feet above the *Inoceramus undulato-plicatus* zone. It is exposed in a cut on Gaston Avenue near the intersection of West Shore Drive, and in the banks of a small branch draining into White Rock Lake 1.6 miles northeast of the dam.

The exact positions of these two zones with respect to the upper and lower limits of the Austin in Dallas County have not been accurately determined. Since the *Gryphaea wratheri* zone is in the middle marly member, it must lie at least 180 feet below the top of the formation. Stephenson is probably correct, therefore, when he estimates the *Inoceramus unlulato-plicatus* zone to be 200 or 250 feet below the top of the Austin in the county.

#### RELATIONSHIP TO EAGLE FORD

Evidence from several localities in the county indicates that the contact between the Eagle Ford and Austin is marked by a disconformity. This fact is not revealed in the earlier literature on the Gulf Series, but has been emphasized in the regional studies of Stephenson (1918, p. 148; 1929).

At the exposure of the contact on Lake View Road, the surface separating the basal pebbly marl of the Austin from the dark shale of the upper Eagle Ford is highly irregular in detail and cuts across the topmost shaly beds. Small channels, a few inches to a foot across and up to three inches deep, are excavated in the shale and filled with the basal marl. Winding tubular burrows, likewise filled with marl, extend downward for about two inches into the shale. Simiiar borings along the same contact in Travis and Hays counties have been described and figured by Stephenson (1929, fig. 2), who attributes them to some burrowing marine organism. Fish teeth and dark casts of molluscan shells are concentrated along the contact, and fragments of reworked shale occur in the lower few inches of the Austin. Essentially the same situation was found at the contact on Keller Springs Road. At the quarry of the Trinity Portland Cement Company the basal beds of the Austin contains, in addition to the usual phosphatic materials, small septaria which evidently were reworked from the upper Eagle Ford.

These facts indicate that sedimentation was locally interrupted at the close of Eagle Ford time. No profound structural disturbance is implied, as the bedding surfaces of the Austin and Eagle Ford above and below the contact are to all appearances parallel. Indeed it is generally necessary to examine the contact with great care to discover any evidence for the disconformity. The local structural significance of the break is thus small, but the time value will be known only after the zonations of the upper Eagle Ford and lower Austin are formulated and compared from place to place.

The disconformity does not necessarily signify that at the close of Eagle Ford time the shales were uplifted and eroded subaerially. More likely the surface of contact between the Austin and Eagle Ford marks a bottom which for a long time was scoured by submarine currents during a pause in sedimentation. During this time there accumulated on the sea floor a quantity of more or less indestructible organic remains such as fish teeth, bones and internal molds of pelecypods and gastropods along with inorganic residues washed from the muds below. These materials were incorporated in the limy muds that later began to cover the bottom with the beginning of Austin sedimentation.

#### CONDITIONS OF ORIGIN

The Austin contains abundant remains of marine organisms from top to bottom. Large thick-shelled oysters and rudistids are fairly abundant, but nowhere form extensive reefs. That the calcareous muds today represented by the beds of chalk and marl were deposited in well aerated marine waters that were neither excessively shallow or excessively deep seems obvious. Beyond this, little is known concerning the conditions of sedimentation. Scott (1940, p. 322) has suggested that the Austin is a deposit of the infraneritic zone, which he defines between the limits of 20 and 100 fathoms.

### TAYLOR FORMATION

#### TYPE LOCALITY AND THICKNESS

The type locality of the Taylor is at Blue Bluff on the Colorado River, 6 miles east of Austin, Travis County (Adkins, 1932, p. 455). The presence of this formation in Dallas County was noted in some of Hill's earlier writings, in which it was usually designated the "*Exogyra ponderosa* marls" or else grouped with the Austin as part of the "Rotten limestone". Only the lower part of the Taylor, amounting to about 600 feet in thickness, is present in the eastern part of the county where the section is thickest.

#### EXPOSURES

In most places the Taylor is covered by alluvium or soil. The best exposures are artificial ones such as are found in clay pits, highway and railway cuts, and excavations for tanks. Good sections may be seen at the clay pit located on the geologic map just south of Ten Mile Creek, in the clay pit of the Dallas Brick Company a half mile west of Mesquite, at the first and third underpasses of U. S. Highway 67 beneath the M. K. & T. railway east of Garland, on the Lancaster-Ferris road south of the crossing over Ten Mile Creek, and in highway and stream cuts around Wilmer.

#### LITHOLOGY AND CHEMICAL COMPOSITION

At the exposures observed within the county the Taylor consists of laminated marl and calcareous shale. The color of fresh specimens is gray, ranging from dark gray in the shales to light gray and almost white in the marls. In general the lower beds are more calcareous than the upper; indeed, at most places it is difficult to distinguish the basal Taylor strata from the underlying top beds of the Austin.

As exposed in highway and stream cuts east of Garland the lower marly beds are finely laminated, although this generally can be seen only on dry specimens. When thor-

Figure 16.—Clay-shale of Taylor formation exposed in pit near Ferris, Dallas-Ellis county line.

oughly moist these beds are highly plastic, and on soaking in water they break down readily into a sticky paste made mostly of clay particles. Specimens only slightly moist are remarkably sectile, and may be carved into thin shavings with a knife. On complete drying the marl becomes almost as white as chalk, and exhibits good conchoidal fracture.

In the clay pit located in the southern boundary of the county (Pl. 1), approximately 60 feet of Taylor is exposed (Fig. 16). This consists of gray clay-shale with thin partings of fine-grained sandstone. The upper 20 feet are brown, due to weathering. Ries (1908, p. 62; 1927, p. 556) has published two analyses of this material, as follows.

**Analyses of Taylor Clays from Ferris, Texas (After Ries)**

| | I | II |
|---|---|---|
| Silica | 47.92 | 49.45 |
| Alumina | 14.40 | 17.11 |
| Ferric oxide | 3.60 | 3.45 |
| Lime | 12.30 | 12.67 |
| Magnesia | 1.08 | 1.77 |
| Soda | 1.50 | 0.21 |
| Potash | 1.20 | 0.13 |
| Titanic acid | 1.22 | 0.70 |
| Water | 4.85 | 4.84 |
| Carbonic acid | 9.50 | 7.10 |
| Sulphur trioxide | 1.44 | 2.00 |
| Organic | 1.34 | |
| | 100.35 | 99.43 |

As in the case of the Eagle Ford shales, those of the Taylor contain limestone concretions and secondary selenite. The concretions of the Taylor, however, tend to smaller, flatter, lighter in color, and less commonly septarian than those of the Eagle Ford.

It is possible that sandy beds belonging to the Wolfe City member of the Taylor underlie alluvium of the Trinity and its East Fork along part of the extreme eastern portion of the county. This is indicated to be the case in a structure section by Scott (1933, Pl. 8) and a map by Dane and Reeside (1928, p. 43). The latter two authors state, however, that no outcrops of the Wolfe City have been found along the portion of Dallas County it supposedly underlies.

### FOSSILS

Most paleontological work to date has been devoted to the microfauna, which is rich and varied. Large samples of Taylor marl or shale yield small concentrates, as most of the disintegrated material will pass through the finest screens ordinarily used by micropaleontologists. These concentrates are made to a large part of Foraminifera, ostracods, prisms from pelecypod shells, and echinoderm fragments.

Very little work has been done on the larger fossils, which are known to include ammonites, pelecypods, gastropods and small corals. The following check list emphasizes the incompleteness of the record.

#### Foraminifera

*Ammodiscus cretacea* (Reuss); Cushman, 1934, p. 44-47. This species is reported from the lower Taylor exposed on the Dallas road, 1.5 miles east of Garland, Dallas County, Texas.

*Kyphopyxa christneri* (Carsey); H. J. Plummer, 1931, p. 171, Pl. 12, figs. 16, 17, 19. Neoparatypes described in this report are from the middle Taylor in a roadside bank close to the underpass at the M. K. and T. railroad on the Dallas-Greenville highway about one mile east of Rowlett. This is the same as Alexander's station 49.

*Marginulina inconstantia* Cushman; Cushman, 1938-b, p. 33, Pl. 5, figs. 4-9. The type locality is in the basal Taylor "just above the Austin contact, E. side of Buckner Boulevard, 2 ft. below pavement 0.1 mile N. of intersection of U. S. Highway 80, near Buckner Orphans Home, E. of Dallas, Dallas County, Texas."

*Eouvigerina americana* Cushman; Cushman, 1926, p. 4-5, Pl. 1, figs. 1a-c. This species is the genotype of *Eouvigerina.* The type locality is the clay pit of the Dallas Brick Co., a half mile west of Mesquite.

*Eouvigerina gracilis* Cushman; Cushman, 1926, p. 5-6, Pl. 1, figs. 2a-c. The type locality is the clay pit of the Dallas Brick Co., a half mile west of Mesquite.

*Loxostoma clavatum* (Cushman) ; Cushman, 1927, p. 87-88, Pl. 12, figs. 5 a, b.; 1937-b, p. 171-172, Pl. 20, figs. 6-8. Originally assigned to *Bolivina*, this species was later classed with *Loxostoma*. The type locality is the clay pit of the Dallas Brick Co., a half mile west of Mesquite.

*Loxostoma tegulatum* (Reuss) ? Cushman, 1927, p. 86, Pl. 12, fig. 2; 1937-b, p. 168-169, Pl. 20, figs. 17, 18. A form which Cushman tentatively assigns to Reuss's species occurs in the clay pit of the Dallas Brick Co., ½ mile west of Mesquite.

*Planoglobulina taylorana* Cushman; Cushman, 1838-a, p. 23, Pl. 4, figs. 9, 10. The type locality for this species is in the basal Taylor marl on the Dallas road 1.5 miles east of Garland, Dallas County.

**Brachiopods**

*Terebratulina guadalupae* (Roemer) ; Hill, 1889-a, p. 8; 1889-b, p. 3. This record is subject to some question. Hill states that Roemer's species (originally assigned to *Terebratula*) occurs in the "*Exogyra ponderosa* marls" of Dallas County. Presumably this means that the specimens reported from the county were found in the Taylor marl, which commonly went by the names "*Exogyra ponderosa* marl" or simply "*ponderosa* marl" in the early literature. However, this large *Exogyra* occurs in the upper Austin of Dallas County, and it may be that Hill found Roemer's species in the chalk. According to Adkins (1928, p. 81) the type locally for the brachiopod is in the Austin chalk near New Braunfels.

**Echinoids**

*Cidaris dixiensis* Cragin; Cragin, 1893, p. 146-147, Pl. 46, figs. 15, 16; Clark and Twitchell, 1915, p. 47, Pl. 9, figs. 7a-b. Only two plates of this echinoid were figured by Cragin, who stated that they were collected by Cummins along "the contact between chalk and Ponderosa marl" nine miles northeast of Dallas. These general directions would seem to place the type locality in the Taylor rather than in the Austin, as Adkins (1928, p. 271) has indicated.

**Pelecypods**

*Diploschiza* sp.; Stephenson, 1937, p. 139. Pelecypods belonging to this genus are reported by Stephenson from the basal part of the Taylor. One locality is on Prairie Creek, 1000 feet upstream from an east-west road, 1.5 miles northeast of Pleasant Grove. Other localities in Dallas County are: (1) 200 feet east of the Southern Pacific Railroad bridge north of Wilmer in a gully on the bank of Cottonwood Creek (2) on a branch of Prairie Creek just above a public-road bridge 1.15 miles east of Pleasant Grove, and (3) at the heads of gullies in the northward-facing slope of a small branch of Rowlett Creek, south of U. S. Highway 67, 1.3 miles east of the public square at Garland.

*Pycnodonta vesicularis* (Lamarck); Hill, 1889-a, p. 11; 1889-b, p. 5; Adkins, 1928, p. 109. This is a doubtful record. See listing of this species in the section of this report on the Austin formation.

**Ostracods**

*Cytherella parallela* (Reuss); Alexander, 1929, p. 50-51, Pl. 1, figs. 13, 16. This species is common at Alexander's station 49. It is not restricted to the Taylor, but occurs also in the upper Austin, where, however, it is less abundant.

*Cytherella bullata* Alexander; Alexander, 1929, p. 51, Pl. 1, figs. 3, 6; p. 51-52, Pl. 2, figs. 4, 6. At Alexander's station 49 the female form of this species (originally described as *C. obesa*) is common, and the male (originally described at *C. austinensis*) is rare. The species occurs in the upper Austin as well as in the Taylor. For further notes on the species refer to its listing in the section on the Austin formation.

*Bairdia rotunda* Alexander; Alexander, 1929, p. 62-63, Pl. 3, figs. 2, 6. This species is common at Alexander's station 49. It ranges through the lower three-fourths of the

Taylor, but is not restricted to this formation, occurring also in the upper Austin.

*Paracypris angusta* Alexander; Alexander, 1929, p. 67, Pl. 4, figs. 3, 7. This species is rare at Alexander's station 49, the type locality. It has been found only in the lower fourth of the Taylor formation.

*Krithe cushmani* Alexander; Alexander, 1929, p. 67-68, Pl. 4, figs. 9-11. In Dallas County this species has been reported from Alexander's station 49, the type locality, where it is common. It ranges through approximately the lower two-thirds of the Taylor, and is most common in the lower Taylor, but it occurs also in the upper Austin.

*Cytheridea perforata* (Roemer) ; Alexander, 1929, p. 72-73, Pl. 5, figs. 1, 2. This species ranges throughout the Taylor, being most common in the lower part and becoming increasingly rare upward. It is common at Alexander's station 49.

*Cythere semiplicata* (Reuss) ; Alexander, 1929, p. 80-81, Pl. 6, figs. 9, 15. This species is common at Alexander's station 49. It ranges from the upper Austin to the top of the Wolfe City sand member of the Taylor.

*Cythere sphenoides* Reuss; Alexander, 1929, p. 81-82, Pl. 7, figs. 9, 14. This species is abundant at Alexander's station 49. The range of this species is about the same as that for *C. semiplicata.*

*Cythere foesteriana* (Bosquet) ; Alexander, 1929, p. 82-83, Pl. 6, figs. 1, 11. This species is common at Alexander's station 49. It is fairly abundant in the lower Taylor clays up to the base of the Wolfe City sand, and it occurs rarely in the Austin.

*Cythere cornuta* var. *gulfensis* Alexander; Alexander, 1929, p. 85-86, Pl. 8, figs. 1, 2, 6. This species has been reported from the Eagle Ford, Austin, and Taylor of Dallas County. It is rare at Alexander's station 49.

*Cythereis dallasensis* Alexander; Alexander, p. 99-100, Pl. 8, figs. 8, 9. This species is of rare occurrence at Alexander's station 49. It is more abundant in the upper Austin.

*Cythereis bicornis* Israelsky; Alexander, 1929, p. 100, Pl. 8, figs. 4, 5. Although this species occurs rarely in the Austin, it is characteristic of the lower third of the Taylor formation up to the base of the Wolfe City sand member. It is common at Alexander's station 49.

*Cythereis rugosissima* Alexander; Alexander, p. 101, Pl. 9, figs. 13, 14. This species is found only in the lower third of the Taylor. It is common at Alexander's station 49.

#### RELATIONSHIP TO AUSTIN

The Austin-Taylor contact was investigated at three localities. The first of these is near Wilmer where the Wilmer-Dallas Highway crosses a small headwater branch of Cottonwood Creek (Pl. 1). The second is along Long Branch, between Centerville Road and Oates Drive, where the Austin occurs along the bottom of the branch in a narrow strip too small to be shown on the geologic map. The third is east of Garland along U. S. Highway 67 near the first underpass beneath the M. K. & T. railroad. No evidence for a disconformity was discovered at any of these localities.

In the highway cut on the south side of the road at the first locality the contact is well exposed. The upper beds of the Austin are of gray calcareous shale and impure chalk weathering light gray to nearly white. These grade with no apparent break into softer buff and brownish calcareous clay-shale of the lower Taylor. At one place a limestone concretion two feet across was found in the lower Taylor beds directly above the contact, but aside from this there is nothing to mark the boundary between the two formations aside from the lithological differences just noted.

On Long Branch, chalk belonging to the upper Austin shows along the bottom of the valley for most of the distance between Centerville Road and Oates Drives. In places along undercut banks the upper part of the bedrock is gray to buff sectile marl containing large fragments of *Inoceramus* and exhibiting conchoidal fracture, whereas the lower part is impure chalk and gray calcareous shale. The contact between the two shows slight undulations, but these do not seem to cut across the bedding of the lower chalky material. If, as seems likely, this is the Austin-Taylor contact, it cannot be said to lie along a disconformity.

About 15 feet of bedrock is exposed on the north side of the highway directly east of the underpass at the third locality (Fig. 17). At the base is 5 feet of gray calcareous shale, which is interpreted as belonging to the uppermost Austin. Overlying this are beds of brownish calcareous clay and sectile marl that certainly belong to the lower Taylor. The contact between the two appears to be sharply defined when viewed from a distance, but on close examination it seems to be gradational with no coarse materials to mark the base of the younger formation. Typical Austin chalk occurs in a creek about 100 yards west of the locality, and material of the same nature is found on the west side of the underpass near the level of the road. The base of the Taylor as here defined thus lies about 5 feet above the highest bed of typical chalk, with the gray calcareous shale intervening.

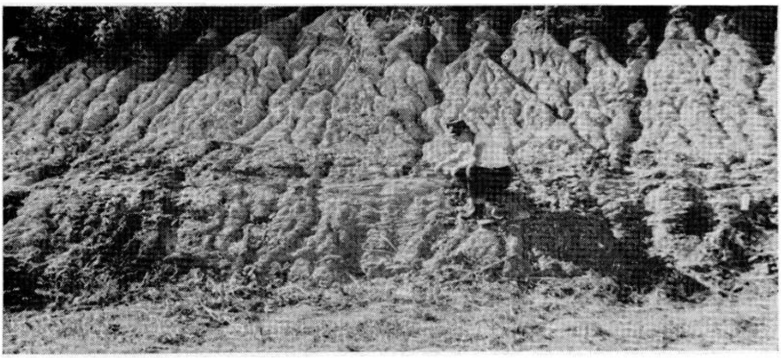


Figure 17.—Possible Austin-Taylor contact (at level of man's hand) exposed on U. S. Highway 67 east of Garland.

Elsewhere in Texas the Austin and Taylor formations are separated by an unconformity (Stephenson, 1929, p. 1329-1330; 1937, p. 146) so that the situation in Dallas County, where the two formations appear to be conformable, has been regarded as unusual. Recently, however, Stephenson has published what he regards as possible evidence for an unconformity in Dallas County.

"No phosphatic material was observed at the Austin-Taylor contact in Dallas County, but the contact is marked by a bed of limestone ranging in thickness from less than 1 inch to 6 inches, which lies at the base of the Taylor; this limestone is granular in texture and contains scattered shells of **Diploschiza** n. sp. and fragments of the shells of **Inoceramus** and ostreids. Although at most places this limestone is nearly parallel to the bedding of the underlying chalk, at one locality on Prairie Creek, 1,000 feet upstream from an east-west road, 1.5 miles northeast of Pleasant Grove, a marked angular discordance was observed between the limestone and the chalk; in a horizontal distance of 100 feet the limestone bed rises from a stratigraphic position 2 feet above a traceable layer of chalk to 9 feet above it, thus apparently indicating an unconformity." (Stehenson, 1937, p. 138)

Thus the question of the local relationships of the two formations must remain for the present unsettled. As it now stands most of the evidence seems to point toward a gradational contact without any structural break such as a disconformity. Stephenson's locality on Prairie Creek must be studied carefully, however, before any decision can be reached. In this connection it should be recalled that small-scale lensing of chalky layers has been observed in the upper Austin, and that a series of lenticular chalk units incompletely exposed might give the effect that Stephenson has described.

#### CONDITIONS OF ORIGIN

The fossils found in the lower Taylor, as it is exposed in Dallas County, indicate that the limy muds of which the formation was built were deposited in marine waters. The generally small amount of bituminous material in the marl and clay suggests that the bottoms on which accumulation took place were covered with well-aerated waters which permitted bacteria and other organisms to destroy the greater part of the organic materials as they accumulated. The conditions of deposition were probably not much different from those under which the Austin was formed, and Scott (1940, p. 322) regards both formations as products of the infraneritic zone.

## CENOZOIC ROCKS

The Cenozoic rocks of Dallas County consist predominantly of materials laid down by the Trinity and its tributaries. Deposition of alluvium began at some undetermined time which was probably in the Tertiary, and continues along the present floodplains. The work of subdividing the Cenozoic has only begun, so that in this report it is necessary to discuss this system in the broadest terms.

### CHANNEL FILLINGS

Ham (1941) has described channel fillings that occur near White Rock Lake, and which may be seen in section along State Highway 114 and the Southern Pacific railway between Richardson and Abrams roads. The curious thing about these fillings is that they are situated on or near the crests of divides that rise 50 or more feet above the beds of existing streams. In transverse profile they show flat bottoms and steep sides, a cross-sectional shape similar to that of many of the present stream channels in the area. One filling measured 175 feet across and 28 feet thick. The fillings consist of brownish clay enclosing caliche nodules, shell fragments, and small pieces of chalk, marl, and calcareous shale. No fossils, except those reworked from the Cretaceous, have been reported. According to Ham, the fragmental material shows no orderly stratification such as stream-laid gravels generally have.

It is obvious that the channels in which the fillings are set were carved by streams. Within the area considered these streams were flowing on the middle marly member of the Austin, and most likely they had dendritic patterns like those of streams today flowing on the marls (Ham, 1941, fig. 3). Once the axial streams had cut through the marl into the lower chalk member, their courses were adjusted to the trends of joints and faults in the chalky beds, and became rectangular in pattern as a result. New tributaries following faults and joints extended their courses toward the divides, and in so doing intersected and destroyed the older dendritic drainage. Portions of beheaded channelways, left as poorly-drained trenches after the joint- and fault-controlled streams had established themselves, were gradually filled by slope-washing and slumping. With the general lowering of the area some of these filled channels were preserved on divides.

This explanation was advanced by Ham. Although it is not proved, it does seem to account for the facts observed in the field.

### TERRACE DEPOSITS

Terraces underlain by alluvium parallel the Trinity and its tributaries. Each terrace marks approximately the surface of a former floodplain along which the streams deposited sediment. At various times the streams cut their valleys deeper, establishing new floodplains at lower levels and leaving remnants of the old flanking the valleyways as terraces. Successively older alluvial deposits thus occur on successively higher terraces. In the Dallas and Carrollton areas at least three well-defined terraces are present, and with further study the alluvium on each might be designated as a formation. A discussion of the terraces as physiographic features is reserved for the section on geomorphology.

Alluvium of the terraces consists of fragmental materials ranging from clay through silt and sand to pebble and cobble gravel. These materials occur as interfingering lenses and discontinuous units that cannot be traced for great distances along the outcrop or readily correlated from exposure to exposure. The coarser gravels form long trains that mark the positions of shifting channelways. These grade laterally and upwardly into the finer sediments that were deposited marginal to more competent currents in the channels. With the information at hand, the deposits on different terraces cannot be distinguished lithologically except in small areas, although future detailed work may establish general lithological differences.

Terrace materials along the Trinity and its main forks have come in considerable part from sources far upstream. Thus many of the gravel deposits contain worn shells of molluscs which have their sources in Lower Cretaceous rocks around Fort Worth and to the west. Terrace deposits along the side streams have been derived from the local Upper Cretaceous rocks. Alluvium in terraces along White Rock Creek is mostly reworked chalk and marl from the Austin formation. Where made of chalk flakes this material is locally called "white rock gravel". In places it is made of foraminiferal sand, a natural concentrate of the Austin microfauna.

The oldest extensive body of alluvium that has been recognized in the county occurs beneath the Love Field Airport near Dallas and around Bethel School in the northwestern part of the county. Alluvium of the Love Field and Bethel terraces is probably part of the same body of sediment, according to Pattillo (1940). No fossils, other than those reworked from the Cretaceous, have been reported.

Below the Bethel terrace in the Carrollton area is a second well-marked bench, the Farmers Branch terrace (Pattillo, 1940). Human bones were taken from gravelly silt underlying this terrace, but the conditions of preservation suggested to Goldstein that they represent a human burial rather than remains contemporaneous with the stream deposits (Albritton, Pattillo, and Goldstein, 1940).

The lowest well-defined terrace at Dallas stands about 50 feet above the Trinity floodplain, and has been named the Union Terminal terrace by Shuler. From the sand and gravel beneath this level have been taken numerous bones of land animals that Hay tentatively assigned to the mid-Pleistocene (Shuler, 1935, p. 52). A collection of bones from the Lagow sand pit in East Dallas was studied by Lull (1921), who identified the following:

*Smilodon cf. fatalis* (Leidy), a sabre-tooth cat;

*Odocoileus* sp., a deer somewhat smaller than the black-tailed deer of today;

*Tetrameryx shuleri* Lull, a new genus and species of four-pronged antelope;

*Bison alleni* Marsh;

*Camelops huerfanensis dallasi* Lull, a new variety of camel;

*Equus* cf. *fraternus* Leidy, a small horse about the size of a modern pony; and

*Elephas columbi* Falconer.

From yellow fine sandy clay about five feet below the surface, workmen at the Lagow pit took human bones consisting of segments of the right and left femur, right and left tibia, right fibula, left horizontal ramus of the lower jaw, and fragments of the calotte. According to G. G. MacCurdy, to whom the bones were sent for examination, the skeleton belonged to a large adult male of the modern type. Shuler (1923) reported the find, and published analyses which showed that the fossilization of the human bones was comparable to that of camel bones from the same body of alluvium. Owing to the hasty manner in which the bones were removed by the workmen, it could not be established beyond doubt that they were part of the "mid-Pleistocene" fauna. It seems likely, however, that such is the case, and archaeologists should take special notice of future reports of human bones or artifacts from alluvium of the Union Terminal level.

Figures for the thickness of various alluvial bodies in terraces are not available.

## FLOODPLAIN DEPOSITS

The floodplain deposits consist of essentially the same kinds of materials as found in the terraces. Dark gray silt, rich in humus, is exposed along the banks of the Trinity in many places. Gravel and sand are likewise found in the bottoms, where the larger bodies suitable for commercial exploitation are generally situated some distance away from the present drainage lines.

Floodplain silts contain abundant remains of partially decomposed plants, snail shells, pelecypod valves, human bones, and artifacts. The way in which these silts preserve the record of man's habitation is strikingly shown at the crossing of the Carrollton-Denton highway over Elm Fork. Here 15 or more feet of silt, sand, and gravel overlie the Cretaceous Eagle Ford shale and form a broad floodplain. At levels around three feet below the surface the silts contain Indian burials, hearthstones, and various kinds of stone artifacts. These relics of Indian occupation disappear upward in the section, and are replaced in the upper few inches of recently-accumulated silt by fragments of beer bottles and rusty sardine cans. As one student playfully observed, this section is remarkable chiefly in that it shows the transition from the Pleistocene to the Obscene.

## STRUCTURAL FEATURES

The Cretaceous rocks exposed at the surface in Dallas County strike north-northeast and dip at low angles toward the east. At some of the larger exposures it is possible to see that the strata have an eastward dip, but the inclination is so low that it cannot be measured directly with a clinometer. The most reliable data for determining regional dip and strike come from well logs. From these data it has been determined that the Upper Cretaceous rocks in the county have an average strike of NNE and a dip of 0°40′ toward the east.

The Cretaceous is broken in many places by joints and small faults. Disturbances by faulting have locally reversed the dip of the strata so that they are inclined toward the west. This is unusual, however, and the faulting observed at the surface is of a minor character. Small flexures are associated with some of the faults.

The disconformity between the Eagle Ford and Austin formations has been described in another section of this report. The most pronounced unconformities that can be observed at the surface are between the Cretaceous rocks and the various alluvial bodies of the Cenozoic. Evidence for these is shown on the geologic map (Plate 1) where the floodplain and terrace deposits are shown to extend in long belts across the strike of the Cretaceous rocks.

### FAULTS AND FLEXURES

Normal faults of small displacement are abundant in the Austin, particularly in the lower chalky member (Fig. 18). The inclination of fault surfaces in the chalk averages between 45 and 60 degrees. Where a fault cuts across interbedded chalk and calcareous shale, it is as a rule deflected at the chalk-shale contacts so as to dip at lower angles in the shale than in the chalk. In the course of field work no fault was found that had a throw as much as 10 feet, and generally the throws are less than 5 feet. Displacements along the Austin-Eagle Ford contact cannot be traced more than a few feet down into the shale, where apparently the deformation was accomplished by plastic readjustments rather than by fracture.

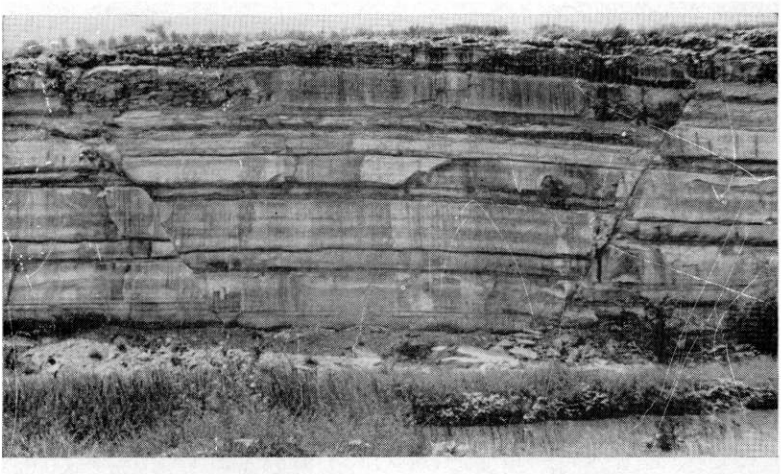


Figure 18.—Small graben in lower Austin chalk. Quarry of Trinity Portland Cement Company.

Fault surfaces in the chalk generally show slickensides, and where the cracks have been filled with calcite these veins preserve on their outer surfaces the minutest details of grooves and striations.

Where the faults are closely spaced, as they are in the area around the Trinity Portland Cement Company, they are generally inclined in various directions so as to form small horst and graben structures (Shuler, 1918, p. 22).

Shuler (1918, fig. 6) plotted the strikes of 33 faults in Dallas County. His diagram shows that, although the faults trend toward almost all points of the compass, there are two maxima respectively 45 degrees east and west of north. In the Chalk Hill area, along the White Rock escarpment east of Arcadia Park, Blakemore (1939) found that the larger faults in the chalk trend around N 10° W. These facts indicate that within the limits of the county the faults trend in various directions, but that within restricted areas the larger examples may be roughly parallel.

Along Cedar Creek, directly adjoining the Marsalis Zoo, the chalky beds are bent upward into a broad, poorly-defined flexure. Apparent dips along this arch do not exceed a few degrees, and whatever trend the structure may have cannot be judged from the sections seen in the bed and banks of the creek. The crest is broken by many faults which seem to be more abundant here than in adjoining areas of normal structure. In other localities the same relationship between low flexures and minor faults has been observed, so that the two may be related in origin.

The nature of the forces responsible for this faulting is not known. One suggestion is that the faults are the result of differential compaction of shale or marl beneath the relatively brittle chalk. The Eagle Ford shales are not perfectly homogeneous, and it is likely that they have been subject to greater thinning by compaction in some areas than in others. The basal chalk, in accommodating itself to these differences, would be warped and broken by faults in the zones of greatest flexing. This may explain the association of the faults and flexures already observed at several places, as well as the abundance of faults in the chalk directly above the Eagle Ford. In a similar manner, differential compaction of the middle marly beds in the Austin might be responsible for faulting of the upper chalk member.

## JOINTS

Joints of two sorts may be seen in the Cretaceous rocks. The first type is characterized by relatively smooth surfaces of fracture that may be plane or curved. Joints of this type are occasionally found in the shales and marls, but they are common only in the chalky beds of the Austin. They intersect the bedding at angles near the vertical, and occur in sets or systems that trend uniformly within small areas. A small amount of differential movement has taken place along some of the joints, which are in effect small faults. Evidently these features owe their origin to shearing stresses of the same sort responsible for the faults.

At least within small areas these joints may be readily grouped into systems with different trends. In the Chalk Hill area, east of Arcadia Park, Blakemore (1939, p. 61) found that the master set of joints is aligned around N 65°

E, and that a secondary set trends within a few degrees of due north. Near White Rock Lake, Ham (1941, p. 18-19) found in the lower chalk two sets of master joints trending N 30° E and N 80° W. Less prominent sets trend N. 63° E, N 58° W, and N 5° W. In the overlying marly beds of the middle Austin, most of the joints seem to trend N 15° E or N 85° W. Joint systems with trends around due north and N 65° E are common to both the Chalk Hill and White Rock Lake areas, and may be master sets for the region.

Joints of the second type have irregular surfaces that define blocks of rock loosened from the outcrop by weathering. They are superficial phenomena that owe their origin, at least in the clayey beds, to tensile stresses attending drying and shrinking of the rocks. They have no definite trends except in that they tend to parallel the surfaces of bedding. They are most closely spaced in the shaly and marly beds which weather into small chips and flakes, and most widely spaced in the flaggy limestones and chalk.

## GEOMORPHOLOGY

The surface of Dallas County has been shaped by streams. Long belts of almost featureless country along the floodplains and terraces owe their origin to deposition of sediment by streams. Valleys that crease the upland areas have been cut and continue to be cut by running water. Even the rounded grassy divides that are not scored by gullies are to some extent shaped by threads and thin films of water that run down their slopes during rains.

Just as water falling on a roof will in time bring into relief the grain of wooden shingles, so streams have brought out the structural grain of Dallas County. Belts of weak rock belonging to the Eagle Ford and Taylor formations have been worn down more rapidly than the intervening belt of relatively resistant Austin chalk. Differential erosion of these gently tilted Cretaceous strata has produced cuestas whose steeper slopes face west and whose gentler slopes, capped by resistant limestone or chalk, slant toward the east. The largest feature of this kind is upheld by the lower chalk member of the Austin, which south of the Trinity stands in bold relief above the Mountain Creek Valley, a lowland cut into the Eagle Ford shales. The steep western face of the cuesta is known as White Rock Escarpment, and the highest parts of the county are along its top.

Since the landscape of the county has been shaped by running water, it is fitting that some account be given of the streams themselves.

## STREAMS

Dallas County is drained by Trinity River and its tributaries. West of Dallas two large branches, West Fork and Elm Fork, join to form the main stream which flows southeast to leave the county at its southeastern corner. East Fork of the Trinity runs for some distance parallel to and just beyond the eastern boundary, entering and leaving the county along a short stretch southeast of Mesquite. North of the latitude of Mesquite the eastern one-third of the county is drained by tributaries of East Fork, of which the main branches are Muddy, Rowlett, Duck, Long, North Mesquite and South Mesquite creeks, in order from north to south. The remainder of the county east of the Austin-Eagle Ford contact drains mostly into the main trunk of the Trinity. On the north side of the river the main tributaries are Hickory, Prairie, and White Rock creeks, of which the last is by far the largest and the only one with headwaters beyond the northern boundary of the county. On the south side are Coombs, Cedar, Five Mile, and Ten Mile creeks, all of which head near the White Rock Escarpment. West Fork has one large tributary (Mountain Creek) on the south and two smaller ones (Delaware Branch and Bear Creek) on the north. A number of relatively short branches enter Elm Fork in the northwestern part of the county. Coming from the east are Straight Branch, the lower part of which has been dammed to form Bachman Lake, Farmers Branch and other small branches near Carrollton. Entering from the west are Cottonwood, Hackberry, and Grapevine creeks.

The Trinity and its main forks are perennial streams of highly variable discharge. Stations for gaging the flow of these streams are located on West Fork near Grand Prairie, on Elm Fork at the Carrollton dam, and at the Commerce Street Viaduct approximately 5 miles downstream from the confluence of West and Elm Forks.

At Grand Prairie gaging station the West Fork has a drainage area of 2,886 square miles. According to a record of 14 years duration the average discharge past this station is 449 cubic feet per second ("second-feet"). The discharge has been as high as 15,400 second-feet (Jan. 23, 1932), and as low as 3.2 second-feet (June 6, 1925) according to Paulsen (1941, p. 38). A 13-year record at the Carrollton dam indicates that Elm Fork, which at this point has a drainage area of 2,535 square miles, discharges an average of 669 second-feet. A maximum discharge of 82,100 second-feet was recorded on May 19, 1935. During excessively dry times, however, there may be no flow at all (Grover, 1939, p. 25).

At the Commerce Street gaging station the Trinity has a drainage area of 6,001 square miles. A record of 36 years indicates an average discharge of 1,375 second-feet. On May 26, 1908, a maximum discharge of 184,000 second-feet was recorded. A minimum record for September 11, 1924, is 6.8 second-feet (Paulsen, 1941, p. 39).

The amount of water discharged by the Trinity and its tributaries represents a relatively small amount of the precipitation that falls in the drainage basins. The difference between the average rainfall over a drainage basin and the runoff from the basin is called the "water-loss". This is usually expressed in inches of rainfall. Thus the mean annual precipitation in the basin of Elm Fork is 31.9 inches, of which an amount equivalent to 3.3 inches is annually discharged past Carrollton dam. The water loss, consequently, is 28.6 inches. This loss represents the precipitation that passes into the air by evaporation and transpiration, or else sinks into the ground to fill or replenish deep natural reservoirs (Williams, *et al.*, 1940, p. 18, 46).

The flow of the Trinity is partly regulated by water storage in several large reservoirs upstream from Dallas. These include Bridgeport, Eagle Mountain, Lake Worth, Mountain Creek, and Lake Dallas reservoirs, which have a combined capacity equivalent to a layer of water one foot thick spread over 777,000 acres, or in other words of 777,000 acre-feet.

In spite of the relatively high water-loss and the regulation of flow provided by reservoirs, the Trinity is subject to occasional large floods which in the past have caused serious damage. Flood stage is 25 feet on the gage at Dallas. During the flood of 1908 the gage height was 52.6 feet. At this time a considerable part of West Dallas was overflowed, railway service was cut off, and basements in the business district of the city were flooded by backwater. The damage caused by this flood was estimated at $2,500,000.

In order to prevent a recurrence of such floods, the channels of the Trinity, West Fork, and Elm Fork have been enclosed by levees, and their discharge past Dallas conducted by some 15 miles of diversion channels along a leveed floodway about 7 miles long. The floodway has a capacity approximately double that of the water discharged during the flood of 1908. Levees average 28 feet high, and the floodway is 2000 to 3000 feet wide. Fry (1929) has given an account of this project, and the reader is referred to his paper for details of construction work. The course of the diversion channel and its relationship to the old channelways are shown on Plate 1.

The creeks and branches of the Trinity and its forks are intermittent streams that are dry in the summer and during long droughts. The tributaries of these secondary streams, in turn, are mostly ephemeral, flowing only during and directly after rains.

### STREAM PATTERNS

As shown on Plate 1, the Trinity and its larger tributaries follow meandering courses along the floodplains. By comparison the smaller branches and creeks are relatively straight. As a whole the stream pattern is dendritic, and since with few exceptions the streams join so as to make acute angles that open upstream, the drainage may be further described as pinnate. Intermittent and ephemeral streams on the Austin chalk commonly have rectangular patterns as a result of adjustment to fault and joint systems (Fig. 23).

### CLASSIFICATION

In many places the bends in the Trinity, Elm Fork, West Fork, and East Fork define meander-belts which are approximately the same width as the floodplains. According to the criteria listed by Johnson (1932, p. 487) these streams would be classified as mature. With the exception of the lower courses of the larger creeks, such as White Rock and Mountain, the remaining streams in the county would be classified as sub-mature or youthful.

Hill (1901, p. 55) has stated that the Trinity is a consequent stream, implying that its original course was determined by the initial constructional slope of the Gulf Coastal Plain. The Trinity came into existence some time during the Cenozoic, and its course was probably established on the Tertiary sediments that extend along the Coastal Plain parallel to the Gulf of Mexico. Subsequently it has extended its headwaters far inland, stripped away the younger rocks, and cut into the Cretaceous and older rocks below. Since the Cretaceous and Tertiary systems in the coastal area of Texas are separated by an unconformity, the Trinity, in the Dallas area, has been superimposed upon the structures in the Cretaceous rocks. It is therefore best classified as a superimposed consequent stream.

Although the Trinity and West Fork flow across the strike of the Cretaceous rocks, tributaries have brought out the grain of the country by extending their courses along the belts of weaker rock and thus causing the belts of harder rock to stand in relief. Mountain Creek extends along the belt of soft Eagle Ford shale that lies west of the outcrop of relatively resistant Austin chalk. The small segment of Elm Fork within the county bears the same relationship to the chalk and shale belts. In similar manner White Rock Creek follows the outcrop of soft marly beds in the Austin. These streams are therefore classed as subsequent, since they have developed by headward erosion along belts of weak rock.

The short westward-flowing tributaries of Mountain Creek, Elm Fork, and White Rock Creek flow in directions opposite to that of the original consequent drainage in these same areas. They are therefore obsequent streams.

Five Mile and Ten Mile creeks have formed on the long back-slope of White Rock cuesta, and flow in the direction of the original consequent drainage. Their present courses could have formed, however, only after the Taylor formation had been stripped from the area. Streams which flow in directions identical with that of the consequent drainage, but which develop at levels lower than the initial slope are called resequent streams, and it seems that the two creeks in question fall into this category. So also may the southeast-flowing branches of East Fork, such as Duck Creek, South Mesquite Creek, and North Mesquite Creek. The East Fork itself, together with segments of Muddy and Rowlett creeks, flows generally with the strike of the Cretaceous rocks, and at least in this area is probably subsequent.

### STREAM CHANNELS

The Trinity and its main forks flow in channels that average between 50 and 75 feet across and have steep subparallel banks. Cretaceous bedrock is exposed in many places along lower levels of the banks, but the upper parts are built mostly of clayey silt. This material when wet moves down into the channels by slumping and earthflow, processes that tend to keep the banks steep. The same situation here described holds also for most of the smaller streams with floodplains along their courses.

Gullies and other minor valleys in the Eagle Ford outcrop are characterized by steep sides and V-shaped profiles. Many of the very small streams have well-developed meanders with steep undercut banks facing gentle-slip-off slopes on opposite sides. Similar features characterize minor drainages in the Taylor and in the middle marly member of the Austin.

Profiles of streams flowing on the Austin chalk are quite different from those described above. Even in the youthful stage of development the gullies tend to have flat floors and steep, near-vertical banks. The floors are generally established on some hard layer of chalk and lateral cutting is thereby concentrated on overlying partings of weak calcareous shale or marl. Differential erosion of the alternating beds of chalk and marl produces flutings along the sidewalls, with overhanging ledges of chalk separated by recesses carved in the shaly beds.

## FLOODPLAINS

Floodplains border the Trinity, its forks, and many of its smaller tributaries, as indicated on Plate 1, where the floodplain deposits are in white. The width of the floodplains are directly proportional to the magnitude of the streams and inversely proportional to the resistance that the rocks over which the streams flow offer to erosion. Thus the Trinity floodplain is widest where the river flows on the Eagle Ford and Taylor formations, narrowest at the passage over the Austin. At the widest point this floodplain is over 4.5 miles across, at the narrowest it is 2500 feet. Floodplains along the minor streams become narrower toward the headwaters and generally disappear entirely in the uppermost reaches.

The floodplains are surfaces of exceedingly small relief that slope gently and almost imperceptibly in the direction of drainage. They are constructional surfaces built of superimposed layers of sediments deposited during the floods. Such relief as they display is due to natural levees, sloughs, oxbow lakes, small gullies, and to artificial features such as gravel pits, dumps, levees, and diversion channels. The configuration of the floodplains along the major drainages in the county is shown in great detail on a series of contour maps issued by the Reclamation Department at Austin.

Low natural levees parallel the stream channels, rising three to five feet above the marginal parts of the floodplains. These levees are unsymmetrical rises with gentle slopes away from the streams and steeper slopes toward them. Since the few feet of their relief is distributed over several hundred feet they can not ordinarily be perceived in the field. They are well defined by the two-foot contour intervals on the reclamation maps, as for example on the Owen Crossing sheet.

Between the levees and the peripheral portions of the floodplains the land is poorly drained and inclined to be swampy. Here and there are small crescentric basins and shallow, winding sloughs representing parts of old channels that have been cut off from the existing drainages. Shallow gullies parallel the main streams for short distances, entering them by way of breaches in the levees that were formed in times of flood.

## TERRACES

All the larger and many of the small stream valleys in the county are bordered by terraces. These benches parallel the valleys, and where undissected form belts of almost featureless terrain inclined gently in the direction of drainage. Generally more than one terrace level can be recognized along the larger streams, in which case the higher succeed the lower as in a stairway with broad treads and low risers. Three main terrace levels have been recognizd along the Trinity at Dallas by Shuler and Kelsey, and along Elm Fork in the Carrollton area by Pattillo. On Plate 1 the general extent of the terraces is indicated by a symbol for alluvium. Further study must be made, however, before the several levels can be differentiated and correlated over the extent of the county.

Shuler (1935) has named the three main terraces of the Dallas area the Union Terminal, Travis School, and Love Field, in order from lower to highest. The level of the Union Terminal terrace is about 50 feet above that of the adjoining Trinity floodplain. It begins at Orange Street and swings by the Courthouse, the Union Terminal, and Sears Roebuck, including also a large part of East Dallas. The Travis School terrace is well exhibited from the Travis School on McKinney Avenue to the crossing of Harwood and McKinney. The highest terrace is named for the area around Love Field airport, which is 100 to 120 feet above the level of the floodplain. On the south side of the Trinity opposite Dallas Kelsey (1935) found terrace remnants which he named after

Marsalis Avenue and tentatively correlated with the Love Field level. The extent of the several terraces in the Dallas area is shown on maps published by Shuler and Kelsey in the papers cited above.

Pattillo (1940) has differentiated and mapped the areal distribution of three terraces in the Carrollton area. These are the Carrollton, Farmers Branch, and Bethel terraces, whose surfaces average about 10, 20 and 70 feet, respectively, above the level of Elm Fork floodplain. Pattillo was able to trace the Bethel terrace to a place where it could be recognized as a northward extension of the Love Field Terrace. Possibly the lower two terraces in the Carrollton area are to be correlated with the lower terraces in Dallas, but this has not yet been established.

The terraces mark former floodplain levels of the Trinity river system. Recurrently the streams have lowered their valleys by erosion so as to establish new floodplains at lower levels, thereby leaving the old floodplains standing in relief as terraces.

The terraces show varying degrees of preservation. As a rule the lower ones are relatively intact and unscored by erosion, whereas the higher have been destroyed by erosion in many places, persisting as isolated remnants in others. Remnants of this sort are well displayed along the east side of Mountain Creek, where they may be seen on the geologic map as outliers on the Eagle Ford formation. Such remnants may generally be recognized by their relatively flat tops and covering of gravel. In places they have the appearance of low mesas.

### UPLAND DIVIDES

Areas above the highest terraces in Dallas county have the form of cuestas or of mammillary plains. The cuestas are formed by differential erosion of interbedded weak and resistant strata that have low angles of dip. The mammillary plains have resulted from mature dissection of uniformly weak rocks.

The cuesta type of topography is best developed along the east side of Mountain Creek. A minor cuesta with its steep face toward the west may be observed in the western part of Arcadia Park and along the regional strike to the south. The relief along the cuesta generally does not exceed 30 feet. Its top is upheld by thin flaggy limestone near the base of the Arcadia Park member of the Eagle Ford.

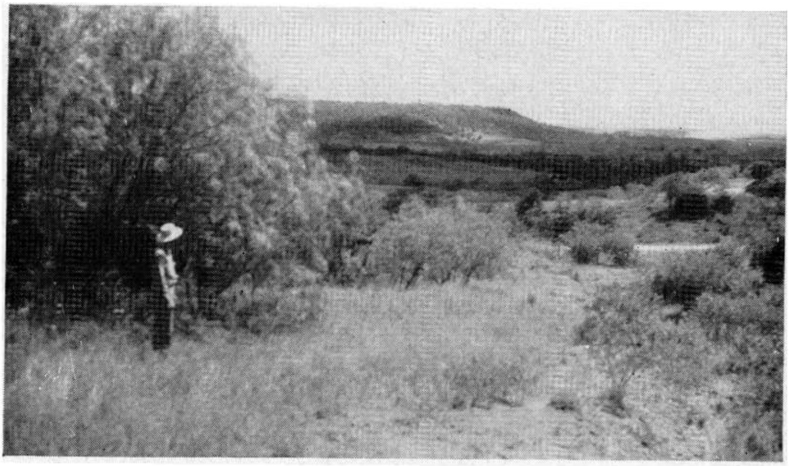


Figure 19.—Profile of White Rock Escarpment, viewed toward south near Cedar Hill.

By far the most impressive cuesta is along the Austin-Eagle Ford contact. It is best observed south of the Trinity, where its steep westward-facing slopes have long been designated the "White Rock Escarpment". The crest lies about two miles east of Mountain Creek and rises approximately 300 feet above the level of this valley. Transverse profiles along the cuesta front are concave upward (Fig. 19), a reflection of the fact that the steepest slopes occur near the crest. The stony soils along the escarpment support a dense growth of juniper, oak, elm, hackberry, and other trees.

In plan the White Rock Escarpment is highly irregular, although the irregularities have a certain amount of symmetry in themselves. Short obsequent streams with steep gradients have frayed the edge of the escarpment, producing a series of alternating "promontories" and "embayments". The trace of the crest line is indicated on Plate 1 by the

Austin-Eagle Ford contact, and it will be noted that within small areas the promontories or embayments have like forms, so that the trace of the crest recalls the sutures on an ammonite shell. Blakemore (1939) has called attention to this and has shown that it is to be explained by the fact that streams invading the chalk are guided in their headward erosion by systems of joints and faults. Since these fracture systems prevail over limited areas with little change in direction, the streams tend to have parallel courses and the interstream areas or promontories acquire similar shapes (Fig. 25).

The gentle backslope of the White Rock cuesta slants to the east in the same direction as the dip of the Austin formation. This slope is not a stratum-plain, however, as its inclination is generally less than the dip of the Cretaceous rocks on which it is developed. Moreover, streams like Five and Ten Mile creeks have eroded the backslope into a submaturely dissected surface.

Figure 20.—Low escarpment along Austin-Eagle Ford contact, viewed along Belt Line Road east of Carrollton.

North of Trinity River the custa topography along the Austin-Eagle Ford contact is much subdued. A low escarpment may be traced north of Bachman Lake to the northern end of the county, but the relief along it is rarely more than 50 feet. Rugged country such as is found south of the Trinity is lacking (Fig. 20). This seems to be due to two facts. (1) North of the Trinity an extensive high-level terrace, probably representing the Love Field-Bethel level, is preserved along the east side of Elm Fork and abuts against the escarpment, reducing its relief. South of the Trinity this terrace has been largely destroyed by tributaries of Mountain Creek. (2) The basal Austin chalk north of the Trinity contains fewer thick and resistant beds of chalk than the lower chalk south of the river.

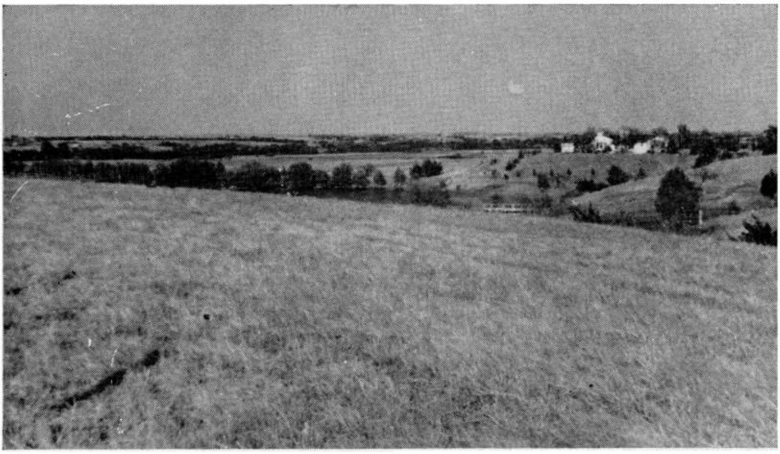


Figure 21.—Typical Black Prairie country. Rounded, grass-covered hills developed on the Taylor formation; between Mesquite and Garland.

With the exception of the area along the White Rock Escarpment the upland portions of the county represent a submaturely to maturely-dissected plain (Fig. 21). The hills are smoothly contoured and circular or elliptical in plan (Fig. 22). Their crests rise from 50 to 250 feet above the bordering drainage-ways. In the native state the hills were covered with grass, and trees formed narrow belts along the water courses. Hill expressively called this type of country a "mammillary plain", and claimed that it resembles the downs of England more than any other part of North America.

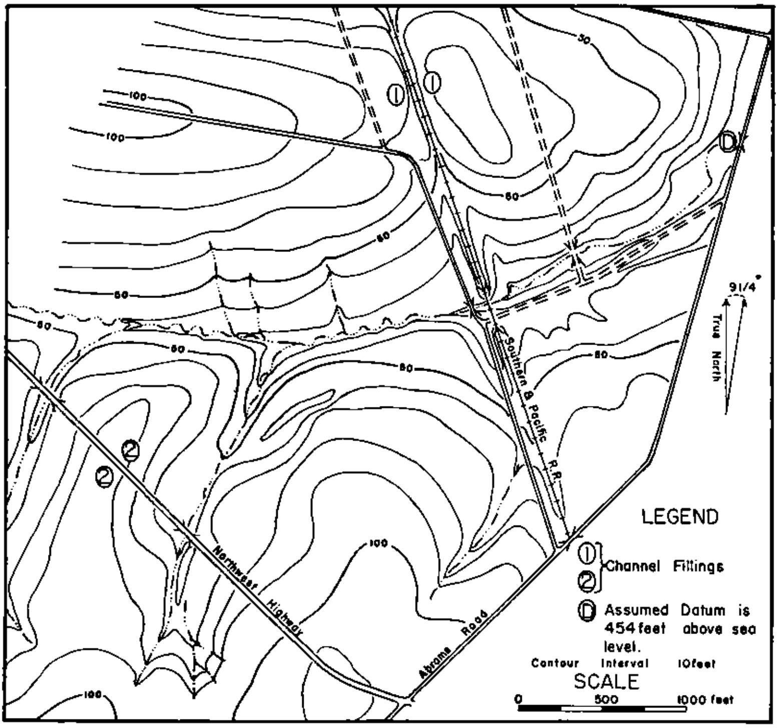



Figure 22.—Topographic map of area west of White Rock Lake showing the form of valleys and divides developed on Austin formation. Numbers indicate positions of channel-fillings. (After Ham)

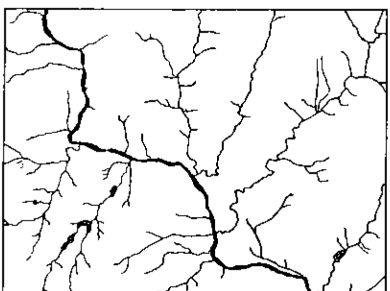


Figure 23.—Drainage pattern of a section of White Rock Creek (heavy black line) showing the control exercised by two sets of joints.

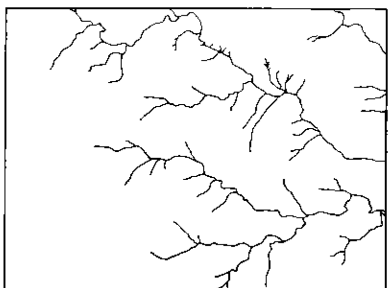


Figure 24.—Dendritic drainage pattern developed by streams flowing entirely on marly beds of the Austin, west side of White Rock Lake.

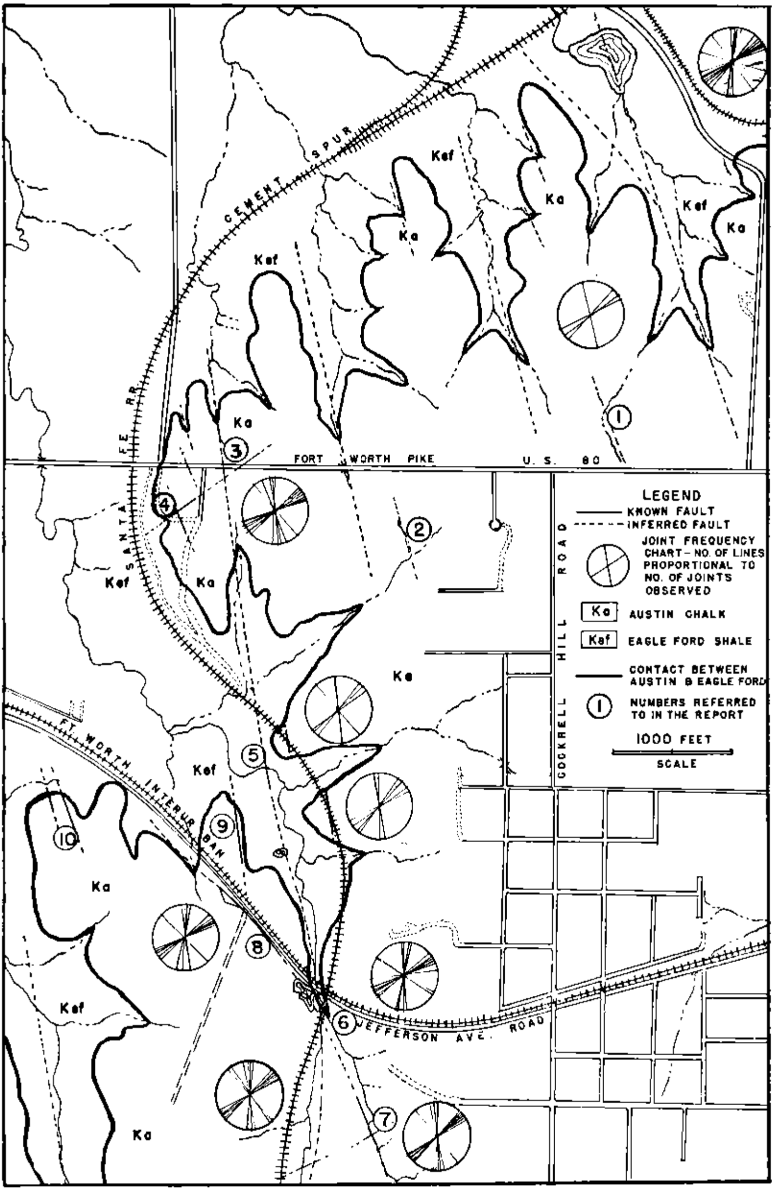



Figure 25.—Map of area along White Rock Escarpmènt east of Arcadia Park. (After Blakemore)

## LAKES

Aside from the small bodies of water in sloughs and meander-scars along the floodplains, the lakes of Dallas County are artificial, formed by the damming of creeks. The largest are Bachman, White Rock, and Mountain Creek. Of these White Rock is most interesting to geologists on account of studies on the silting of the reservoir made by Taylor (1930, p. 87-92), Eakin (1939, p. 10-11; 78-82), and by Marshall and Brown (1939).

White Rock reservoir was built in 1910 at an approximate cost of $765,000 to supply Dallas with water. Since July, 1930, the lake has been used as a recreational unit of the city. The original length of the lake at crest stage was 5.09 miles, and the watershed upstream includes 99.6 square miles of Dallas and Collin Counties. Since the time of its formation White Rock Creek has built a large delta at the upper end, considerably reducing the capacity of the reservoir and converting the upper end of the lake into a shallow swampy tract. By 1935, after 25 years of silting, the area of the lake at crest stage had been reduced from an original 1,254 acres to 1,150 acres. During this time silting had reduced the initial storage capacity from 18,158 acre feet to 14,276 acre feet, a loss of 3,882 acre feet. The total sediment that had been deposited below crest level, accounting for this loss, was partly in the form of delta deposits below crest level (1,256 acre feet) but mostly in bottom-set beds distributed over the reservoir floor (2,626 acre feet). Marshall and Brown have noted that the total accumulation of sediment up to 1935 amounts to 169,000,000 cubic feet, representing an average annual accumulation of 6,764,000 cubic feet. Expressed in terms of mass, White Rock Creek in 25 years transported 3,916,700 tons of sediment to the reservoir, reducing its capacity by 21.38%.

The sediment in the White Rock delta is mostly gray to black clay, containing a considerable amount of organic material in the form of twigs, dead weeds and limbs of trees. Over the bottom of the lake there is a comparatively uniform blanket of fine, dark brown silt or oozy mud (Eakin, 1939, p. 82).

According to the findings of Marshall and Brown, the silting of White Rock Lake gives an exaggerated impression of the mechanical load that White Rock Creek would carry in normal times. Much of the erosion in the drainage basin seems to be of the accelerated sort that is caused by improper agricultural practices. Before the settlement of the country by white men, therefore, this and similar creeks were accomplishing far less in the way of erosion than they are now.

## SOILS

Of the five principal factors of soil formation—parent material, topography, climate, activity of organisms, and time—the first two are geological. Any classification of soils that takes into account the character of the parent rock or the configuration of the country will therefore be of interest to the geologist. The soils of Dallas County have been classified on the basis of simple physical and chemical properties, such as color, texture, and content of calcium carbonate. These properties reflect the nature of materials from which the soils were derived. Moreover the nineteen different types of soil that have been recognized in Dallas County may be separated into three groups on the basis of their topographic positions. One group includes the upland soils, developed by weathering of the Cretaceous bedrock. The second includes soils of stream terraces, and the third includes soils of the floodplains. In contrast to the first group, the last two are developed on Cenozoic alluvium rather than on the older rocks of Cretaceous age. Thus a map of the county showing the distribution of different types of soils might be expected to convey a considerable amount of geological information as well. Such a map, prepared by W. T. Carter and his associates, was published in 1924 in connection with a bulletin on soils of the county. In the paragraphs that follow brief descriptions of the soils are given, and an effort is made to correlate some of the geologic and pedologic data.

## UPLAND SOILS

### HOUSTON SERIES

The Houston soils are characteristically black or brown at the surface, and brown, yellow, grayish, dark bluish gray, or black in the lower portions. Residual from calcareous rocks, they usually contain enough calcium carbonate to effervesce when treated with acid. Houston soils are the most widely distributed of any in the county, covering in all about 40% of its area. They are most extensively developed on lands underlain by the Austin and Taylor formations, and the areal distribution of these two formations as shown on the geological map is essentially the same as the distribution of Houston soils as shown on the soil-survey map. Within the county and west of the Austin-Eagle Ford contact Houston soils occur only in two areas. One is a small patch northwest of Grand Prairie and south of West Fork just within the western boundary of the county. The other and larger area stretches along the western margin of the county between the upper reaches of Grapevine and Bear creeks. In both these areas the soils are residual on the lower, relatively calcareous strata of the Eagle Ford.

Two types of Houston soils are recognized in the county: the Houston black clay and the Houston clay.

*Houston black clay.*—The upper 12 to 15 inches of this soil are dark gray to black, and the subsoil is generally lighter in color—dark gray, brown, yellowish brown, yellow or greenish yellow, depending on the topography and character of the source material. At depths between two and five feet the subsoil grades into the bedrock, which is chalk, marl, calcareous shale, or calcareous clay. The area underlain by this black soil, popularly called the "black land" or "black waxy land", represents approximately a quarter of the entire county.

The black clay is most extensive north of Trinity River and east of Elm Fork, where it covers most of the country shown on the geological map in the patterns for the Austin and Taylor formations. South of the Trinity and east of Mountain Creek this soil occurs in irregular belts and strips along Little Bear Creek and along upper reaches of branches tributary to Five Mile and Ten Mile creeks. The large outcrop of Eagle Ford shale extending along the western margin of the county north of West Fork is likewise marked by the black clay.

*Houston clay.*—In contrast to the dark gray or black topsoil of the Houston black clay, that of the Houston clay is brownish, ranging from grayish brown to dark brown. The subsoil is of a lighter color: grayish brown, brown, or grayish yellow. In many places the Houston clay is underlain at depths of 18 inches or less by bedrock; such thin soils have been mapped separately by the soil survey as the "shallow phase" of the type.

The Houston clay is most extensively developed on the Austin formation, to which the shallow phase appears to be restricted. The deeper Houston clay soils occur also on the Taylor, in the form of long strips paralleling tributaries of the Trinity and East Fork. Only one area within the Eagle Ford outcrop has been mapped as Houston clay. This is the small area, previously mentioned, that lies northwest of Grand Prairie and south of West Fork. Altogether this type of soil covers about 16% of the county.

#### ELLIS CLAY

The Ellis is a compact brownish clay at the surface. At depths between 8 and 12 inches it is underlain by greenish-brown or greenish-yellow clay which becomes lighter in color and more yellowish with increasing depth. At least within the limits of the county this soil type is restricted to areas underlain by the Eagle Ford shale. Only about 3% of the county is covered by the Ellis, the two largest areas lying along the east side of Mountain Creek and the west side of Elm Fork.

### TERRACE SOILS

#### BELL CLAY

"The typical Bell clay consists of a black or dark ashy gray clay, which either shows but little change in the 3-foot section or passes into ashy-black or dark ashy gray clay having a faint bluish cast" (Carter, *et al.*, 1924, p. 1234).

Generally both the soil and subsoil are calcareous, and small caliche nodules are common. This type is underlain by gravel, which affords good subsurface drainage in most places.

The Bell clay is found on terraces along the Trinity and its tributaries. On the soil map differentiation is made between a high and a low phase. The high appears to mark the extent of the Love Field and Bethel terraces. In the Carrollton area the low phase seems to lie at the level of the Farmers Branch terrace. Together the two phases of the Bell account for about 11% of the county.

#### LEWISVILLE CLAY

The Lewisville is brownish clay at the surface, passing into light brown and yellowish-brown clay at depths around a foot, and into yellow or greenish-yellow clay at depths around a yard. Locally the soil is gravelly.

A little more than 9% of the county is covered by Lewisville clay. This soil occurs on terraces along the Trinity and its major tributaries, but does not seem to be restricted to a single terrace level. In Dallas the Lewisville marks the level of the Travis School terrace (Shuler, 1935, p. 51), but a low phase of this soil is found along a relatively lower and presumably younger terrace east of Mountain Creek.

#### CAHABA FINE SAND

Superficially a gray or brownish, loamy fine sand, the Cahaba fine sand grades downward at depths around a foot into yellowish or reddish-yellow loamy fine sand. At the surface this dries to a gray color, owing to a thin coating of loose sand, which may drift with the wind. This soil covers less than 1% of the county, occurring on low terraces along the Trinity and its West and Elm forks. This type appears to be coextensive with parts of the Union Terminal terrace.

#### CAHABA FINE SANDY LOAM

The surface soil is brownish or yellowish friable sand or loamy fine sand 10 to 14 inches deep; the subsoil is fine sandy clay with a reddish cast. The type marks approximately the extent of the Union Terminal terrace at Dallas, the Carrollton terrace along Elm Fork, and terrace levels around Irving which are probably to be correlated with these two. A low phase of this same type is distinguished on the soil survey map, so that it is probable the soil occurs at more than one terrace level.

#### LEAF GRAVELLY SANDY LOAM

The surface soil of this type is a brownish sandy loam less than a foot thick. Subsoil is red or yellowish clay becoming mottled gray with increasing depth. Gravel is scattered throughout. The type covers about 0.3% of the county, occurring as patches that mark terraces along valleys between Bear and Cottonwood creeks in the western part of the county.

#### LEAF FINE SANDY LOAM

This type is a "brown fine sandy loam grading at about 2 to 4 inches into a yellowish-brown, brownish-yellow, or pale-yellow fine sand or fine sandy loam, which extends to a depth of 8 to 15 inches" (Carter, *et al.*, 1924, p. 1243). The subsoil is brownish sandy clay grading down at a depth of about 20 inches into varicolored clay which becomes increasingly gray with depth. This soil marks the position of a broad terrace between South Mesquite Creek and the Trinity, and occurs extensively on terraces around Irving. In all this type of soil covers slightly more than 4% of the county.

#### AMITE FINE SANDY LOAM

The Amite has a topsoil of reddish-brown loamy fine sand which grades at depths around a foot into a subsoil of friable red sandy clay. "This type occurs in a few small areas on old terraces in the western part of the county along the Tarrant County line" (Carter, *et al.*, 1924, p. 1244). The Amite covers less than 1% of the county.

#### KALMIA FINE SAND

The Kalmia is an unindurated fine sand, gray or brownish-gray through the first 3 to 8 inches and pale yellow at greater depths. The type covers only about 0.3% of the county, and is restricted to low terraces which lie only a few feet above the floodplains of Trinity River, Elm Fork, and West Fork. Pattillo (1940, map) includes the Kalmia in the group of soils marking the Carrollton terrace in the area southwest of Farmers Branch, and it is probable that this soil type is to be correlated with the same terrace system in other parts of the county.

#### IRVING FINE SANDY LOAM

The upper 8 to 12 inches of this soil consist of gray to brownish-gray fine sandy loam; the subsoil is dark gray clay which becomes more compact with depth. Locally the soil is gravelly and concretionary. This type occurs as small patches along the lower terraces of the West and Elm forks of the Trinity and in the area around Irving, the total surface covered representing only about 0.5% of the county. Occurrences along the north side of the Trinity have been mapped by Kelsey (Shuler, 1935, p. 49, fig. 1) with the alluvium of the Union Terminal terrace.

#### IRVING SILT LOAM

The topsoil of this soil type is a silt loam of ashy gray color, passing at depths between 8 and 10 inches into clay of the same color. The soil is non-calcareous. Together with the other soils of the Irving series and the Leaf fine sandy loam, the Irving silt loam marks the position of terraces which possibly are to be correlated with the Farmers Branch terrace of the Carrollton area and the Travis School terrace of the Dallas area. This type covers about 0.2% of the county, and is most widely developed in the area around Irving.

#### IRVING CLAY

A dark gray, brownish, or black clay, the Irving is superficially similar to the Bell clay, but lacks calcium carbonate both in the topsoil and subsoil. The clay covers about 2% of the county, occupying terraces in the area between South Mesquite Creek and the Trinity, and distributed in several smaller patches around Irving. Correlation of this soil type with the terrace levels recognized by Shuler, Pattillo, and Kelsey remains to be made.

### FLOODPLAIN SOILS

#### TRINITY CLAY

The top foot of the Trinity clay is dark brown to black; the underlying soil is generally a shade darker. Both surface soil and subsoil are calcareous. In many places this soil overlies gravel and sand deposits, which are encountered at depths generally 3 or more feet below the surface. The Trinity clay covers 15.3% of the county. It is the typical soil on the floodplains of the Trinity, East Fork and its tributaries, the greater part of Elm Fork below Carrollton, and the lower part of West Fork. It is developed also along most of the larger creeks that drain into the Trinity: White Rock, Five Mile, and Ten Mile.

#### CATALPA CLAY

The surface soil of the Catalpa is a brown clay. At depths from 6 to 12 inches this grades into clay of a lighter brown or grayish color. Like the Trinity clay, the Catalpa is calcareous. The chief difference between the two soils lies in their colors, the Catalpa soils being less dark than the Trinity. This soil type is most extensively developed along the floodplain of Mountain Creek, along the upper part of the Elm Fork floodplain, and along segments of Ten Mile Creek. In all it covers about 3% of the county.

#### FRIO LOAM

Near the surface the Frio loam is grayish brown. At depths between 6 and 12 inches it grades into brownish or yellowish loam, sandy loam, or silty clay. This type, which covers only about 0.1% of the county, characteristically occurs as small strips along streams in the western part of the county, as along Denton Creek and the West Fork.

#### FRIO CLAY

This is a brownish silty clay which becomes lighter in color with depth. The material is calcareous throughout. This soil type covers approximately 1% of the county. It is best developed along the floodplain of West Fork, but occurs in smaller patches or belts along Denton and Walnut creeks, respectively at the northwest and southwest corners of the county.

#### OCHLOCKONEE CLAY LOAM

This is a brownish clay loam or sandy clay loam with a clay subsoil developed in places. The type covers only 0.1% of the county, and is restricted to two small areas in the Bear and Delaware Branch bottoms in the western part of the county.

## CORRELATION OF GEOLOGIC AND PEDOLOGIC DATA

A summary of the classification and distribution of the various soils in Dallas County is given in the following table, which represents a rearrangement of data given in the soil survey bulletin (Carter, *et al.*, 1924, p. 1227).

| Soil Type | Area Covered in Dallas County | |
|---|---|---|
| | Acres | Per Cent of Total Area |
| *Upland Soils* | | |
| Houston black clay | 139,392 | 24.5 |
| Houston clay | 92,034 | 16.2 |
| Ellis clay | 16,704 | 2.9 |
| *Terrace Soils* | | |
| Bell clay | 64,960 | 11.4 |
| Lewisville clay | 52,736 | 9.3 |
| Cahaba fine sandy loan | 26,432 | 4.6 |
| Leaf fine sandy loam | 24,320 | 4.3 |
| Irving clay | 11,712 | 2.1 |
| Cahaba fine sand | 4,672 | 0.8 |
| Irving fine sandy loam | 2,688 | 0.5 |
| Kalmia fine sand | 2,048 | 0.3 |
| Leaf gravelly sandy loam | 1,792 | 0.3 |
| Amite fine sandy loam | 1,216 | 0.2 |
| Irving silt loam | 1,152 | 0.2 |
| *Floodplain Soils* | | |
| Trinity clay | 87,040 | 15.3 |
| Catalpa clay | 17,856 | 3.1 |
| Frio clay | 6,208 | 1.1 |
| Ochlockonee clay loam | 832 | 0.1 |
| Frio loam | 768 | 0.1 |

Aside from the uses for which it was primarily intended the soil report of Carter and his associates supplies many interesting geological data. Comparison of the figures on relative distribution of upland and alluvial soil shows that the three types of upland soils cover 43.6% of the county, whereas the sixteen types of alluvial soils (terrace and floodplain) cover 53.7% of the county. Since the upland soils mark the distribution of the Cretaceous rocks, and the alluvial soils show the distribution of Cenozoic deposits, the relatively greater areal extent of the younger system is at once apparent. From this comparison one also gains a quantitative idea of the large areas over which streams have deposited sediments. The distribution of floodplain soils as indicated on the soil map clearly marks areas along which most of the contemporary alluvial deposits are forming. These areas amount in all to 19.7% of the county. The distribution of terrace soils indicates the areas that retain alluvium which for the greater part was deposited in the past. These areas aggregate 34% of the county.

That there are many more types of alluvial than upland soils in the county reflects the fact that, as regards lithology, the Cretaceous bedrock is relatively homogeneous in comparison with the Cenozoic stream deposits. The inorganic materials in the upland soils are of local origin, residual upon the bedrock they mantle. But the materials in the terrace and floodplain soils have been brought from many different kinds of source materials upstream, both within the county and beyond its boundaries.

Soils are virtually absent along the crest of the White Rock escarpment from the Trinity to the southern edge of the county. This reflects the fact that along the steep slopes prevailing in this belt soil erosion is keeping pace with soil formation. The soil map, in fact, has a special pattern for chalk outcrops, which account for approximately 2.6% of the county's area.

The Eagle Ford-Austin contact south of the Trinity is approximately indicated on the soil map by the line separating the patterns for the chalk and the Ellis clays, since the Ellis occurs only over Eagle Ford shale. In some places, however, soil types other than the Ellis are developed on the Eagle Ford. For example, the large outcrop of lower Eagle Ford shale along the western margin of the county is mantled with Houston black clay. Both Houston and Ellis soils are residual, but the former is typically calcareous whereas the latter is not. Thus it would seem that at least locally the Eagle Ford is more calcareous in the lower part of the section than in the upper.

As one would expect from the calcareous nature of both the Austin and Taylor formations, the contact between the two is not sharply marked by a difference in residual soils. The shallow phase of the Houston clay, however, appears to be restricted almost entirely to areas of Austin bedrock, so that a line joining the most easterly occurrences of this type as shown on the soil map approximately defines the contact between the two Cretaceous formations.

The chief use of the soil map in future refinements of the areal geology will come when comprehensive work is begun on mapping the various terrace levels and subdividing the Cenozoic alluvium. Some work toward a correlation of soil types with terrace levels has already been done, and these correlations have been mentioned in the descriptions of soil types. Full use of the pedologic data, however, has not been made. Once the various soil types are correlated in the field with local terrace levels, the distribution of terraces and terrace remnants may be established on the soil map with small effort.

# ECONOMIC CONSIDERATIONS

## SOILS

Soils constitute the most important natural resource of Dallas County. In 1924 about 83% of the county was under cultivation. Since that time additional land has been cleared or reclaimed, although the work of soil conservationalists indicates that some of the farm land should be converted into pastures in order to avoid soil erosion.

The different soil types are suited to different kinds of crops. According to Carter (1924) the Houston black clay and Bell clay are highly productive soils well adapted for the growing of cotton, corn, wheat, oats, forage crops, and grass. "The Houston clay and Lewisville clay are well suited to oats and wheat. The Houston clay, shallow phase, is better suited to small grains than to corn and cotton. The Ellis clay is better suited to wheat and oats than to corn or cotton. The Irving clay is well suited to wheat, oats, and cotton, and not so well suited to corn as the Bell clay and Houston black clay. The Cahaba soils are especially adapted to the production of vegetables and fruits. The Leaf fine sandy loam is also well suited to vegetables, though not quite so well as the Cahaba fine sandy loam. Trinity, Catalpa, and Frio soils are very productive bottom soils and with good drainage are especially suited to corn, cotton, alfalfa, and forage crops." (Carter, *et al.*, 1924, p. 1253-1254)

A detailed study of soil erosion and land use conditions in the White Rock Watershed has been made by Marshall and Brown (1939). They found that accelerated erosion has affected 92.6 of the 99.6 square miles of the watershed. One-fourth of the original topsoil has been eroded from more than half this area. 25% to 75% of the topsoil has been washed away from areas that aggregate more than one-third the area of the watershed. Most of this erosion has taken place during the 75 years that the area has been farmed, and a large part of the watershed will be rendered unproductive if the present rate of soil erosion is allowed to continue unchecked.

Accompanying the report of Marshall and Brown are detailed maps (Scale: 4 inches to 1 mile) on which the land is classified according to degree of slope, type of soil, state of preservation of soil, and land use. Four types of slopes, designated by the letters A, B, C, and D, are recognized. A-slopes are those whose inclination is less than 1 degree. Slopes of this group include 45.4% of the watershed. These are the nearly level areas that suffer little erosion regardless of tillage practice. B-slopes, whose inclinations lie between 1 and 6 degrees, account for 49.2% of the watershed. The B-slopes erode when cultivated except where erosion is prevented by proper tillage practices. C-slopes are inclined between 6 and 10 degrees, and account for 5.4% of the watershed. These slopes erode where cleanly cultivated, but are suitable for close-growing crops. All slopes of inclinations greater than 10 degrees are classed as D-slopes. These slopes account for only 0.1% of the watershed. They are too steep for any sort of cultivation and should be left covered with native vegetation. Slopes of classes C and D are practically restricted to the breaks along streams.

The maps published by Marshall and Brown will provide excellent bases for future geologic mapping in the White Rock Watershed. They will be of value also the physiographers interested in the problems relating to the formation and retreat of slopes.

## STONE FOR BUILDING AND ROAD MATERIALS

In the early days of settlement the Austin chalk was sometimes used for building stone. It could be easily quarried or sawed, and upon drying acquired the requisite amount of hardness for building stone. The local chalk has never been quite satisfactory for this purpose, however; it chips readily and the marcasite concretions in it soon decompose to limonite which leaves ugly brown stains on the white surfaces. When other building materials become available, therefore, the chalk was used for other purposes.

Today the harder beds of chalk are quarried extensively for road metal. Broken chalk has an advantage over harder materials in supplying gravel for driveways and road foundations. With moderate weathering it disintegrates to a certain extent, cementing itself into a mass almost as resistant as the original chalky strata themselves. The numerous quarries over the county attest the value of the chalk as road metal, and today, as a hundred years ago, it provides the only firm natural foundation for homes and buildings.

## CLAY

Clays suitable for the making of brick occur in the alluvial deposits of the Trinity Valley, in the Eagle Ford formation, and in the Taylor. In the early days of settlement the alluvial clays were extensively used, but when experience showed that they were exceedingly localized in their extent and graded laterally into sand and gravel, attention was given to the more extensive and more homogeneous Cretaceous deposits.

The Eagle Ford clays of West Dallas have been used for making dry-press brick, red-burning, which Ries has judged to be of excellent quality. According to this same authority, however, the Eagle Ford clay-shale "contains about all the undesirable elements that a clay might have, namely, concretions, limestone pebbles, gypsum lumps, and even pyrite. Moreover, its bituminous character, as well as extreme toughness, causes great trouble in its manipulation" (Ries, 1927, p. 552).

Today most of the brick manufactured in the county comes from the Taylor clays. These have been extensively worked west of Mesquite and around Ferris, just south of the county line. The county has great potential supplies of clay for making brick, and the sites for working the clay are located largely with respect to convenience in transporting the finished product.

## MATERIAL FOR PORTLAND CEMENT

The chief raw materials for portland cement are limestone and clay. The Trinity and Lone Star cement companies have large plants in West Dallas which utilize the upper shales of the Eagle Ford and the lower chalk of the Austin along the contact between the two formations. The supplies of both materials are almost without limit, and the location of these plants has been determined to a large extent by accessibility to railway facilities.

## SAND AND GRAVEL

The sand and gravel taken from pits along the floodplain and terraces of the Trinity are practically the sole source of concrete aggregate, railroad ballast and plastering sands for Dallas, Fort Worth, and the territory within a hundred miles or so (Shaw, 1928). The larger deposits contain anywhere from 200,000 to 2,000,000 cubic yards of good sand and gravel. Pits from which these materials have been extracted are scattered along the floodplain of the Trinity and its main forks, and the mounds of material discarded from these workings are the largest relief features on the floodplains. The supplies most conveniently located with respect to highway and railway facilities are nearing depletion, so that attention is now being turned to the less accessible deposits.

The gravel and sand are taken from open pits, after the overburden has been stripped away. Some of the gravel is clean enough for immediate use, but most of it must be screened and washed.

# PROBLEMS FOR FUTURE INVESTIGATION

There is great need for detailed stratigraphic work on every formation in the county. The complete picture of the lithology of the Cretaceous strata will develop only after a number of sections at critical localities have been carefully measured, collected for fossils, and correlated so as to provide a reference column that can be studied at the surface and used to interpret the subsurface data. This will be a difficult task for the Eagle Ford and Taylor formations, which are well exposed at relatively few places, but should be somewhat easier for the Austin, which crops out over wide areas.

The Cenozoic rocks must someday be subdivided into formations that can be shown on an areal map. In order for this to be done, the terraces along the streams must be correlated and mapped over the extent of the county, and the terrace deposits studied and compared with regard to lithology and paleontology.

Only after this stratigraphic work has been done can the geologic column be satisfactorily subdivided into formations and members. Most likely it will be possible to subdivide the Eagle Ford and Austin formations into mappable units that are distinctive lithologically. Some progress in this direction has already been made. With some revision Moreman's subdivision of the Eagle Ford may stand, and further study may warrant the naming of at least three members in the local section of the Austin. It is to be urged, however, that in future refinements of the stratigraphy there be no mistaking of zones, defined on the basis of fossils, for formations or members, defined on the basis of lithology.

Relatively few of the fossils to be found in the county have been figured and described, or even reported. There is a fair amount of descriptive literature on the ammonites of the Eagle Ford, although the type localities for a number of species have been designated by such general terms as "found on Elm Fork", and such localities, if possible, should be redefined more specifically. Thanks to Stenzel something is known regarding the fossil crustacea of the shales, and Alexander's work on the ostracods is to be highly commended. The Foraminifera have not yet received critical study, and little is known of the pelecypods, gastropods, worm tubes, and corals that almost every collector has taken from the Eagle Ford.

The microfaunas of the Austin and Taylor formations have received a certain amount of attention from paleontologists, and several species of Foraminifera and ostracods have type localities within the county. There is great need for accurate check lists, however. Aside from the findings of Stephenson, little has been recorded concerning the larger fossils of these formations.

Cretaceous vertebrates have been found in considerable numbers. Fish teeth and bones are rather abundant in the Eagle Ford and Austin, and remains of large marine reptiles are occasionally reported. The vertebrate paleontology of the county, however, largely remains to be written.

This is not to discount the excellent work of Lull, who described a number of Pleistocene vertebrate fossils from the Lagow sand pits. Shuler, also, has been active in collecting and reporting the Pleistocene fossils. His paper on the human bones from the Lagow pit is an important contribution to the rapidly growing literature on early man in North America.

Archaeologists and geologists find common ground in the Cenozoic sediments. Cooperative work on their part will be necessary before the Pleistocene sequence and history can be formulated. Artifacts occur in the floodplain along Elm Fork and elsewhere, and it is anticipated that they will be found in deposits beneath the Union Terminal terrace.

Where fossils are collected special note should be made of the horizons at which they occur and of their associations at different horizons. From these considerations there should evolve the basis for detailed zonation and correlation of the formations, as well as a body of information important to the growing science of paleoecology.

Work on the geomorphology was fathered by Hill and has been carried on by Shuler and his students. Terraces along parts of the Trinity and Elm Fork have been differentiated and mapped, but today the correlation of terrace levels between these two areas is not certain. Every phase of the geomorphology needs further investigation, and future workers should take advantage of the excellent detailed maps issued by the State Reclamation Department and the United States Department of Agriculture.

There are several phases of the local geology that are well adapted for consideration by students of geology in local or nearby universities. Accounts of the concretions, selenite crystals, and limestone lentils in the Cretaceous formations could be worked into short papers worthy of publication. Mapping of joint and fault-systems in the Austin would involve a great amount of routine work, but might provide the basis for understanding the nature of forces responsible for these structures. Study of the Cretaceous rocks in thin-section, a technique all too often regarded as applying only to the investigation of igneous and metamorphic rocks, might shed light on phases of sedimentation that heretofore have been overlooked.

One grows a little weary of reading, and writing, that "the Cretaceous sediments were deposited in shallow seas". Just how shallow were the waters that received the sediment we see today as layers in the Eagle Ford, Austin, and Taylor formations? Scott has approached the question with some success from the viewpoint of paleoecology, and his tentative answers are the more to be commended in that they attempt to be quantitative. Here is a fundamental question, though, that remains unsettled—one that may well tax the ingenuity of geologists for several generations.

Since it is much easier to pose questions than answer them, this section will not be prolonged further. It is hoped, however, that the problems raised by this investigation will stimulate the amount of research necessary for solving them.

# FIELD TRIPS

The following two field trips are designed for those who would like to see some of the geology of Dallas County first-hand. A minimum of three hours should be allowed for trip 1, one hour for trip 2. Mileages are given so that points of interest may be readily located by automobile.

On trip 1, one sees the Austin formation, Taylor formation, Austin-Taylor contact, and alluvial deposits of White Rock Creek and Trinity River. At different places one sees terraces along White Rock Creek and the Trinity, White Rock Lake, the Trinity floodplain, and other items of physiographic interest.

Trip 2 affords good views of the lower Austin and the upper Eagle Ford formations, and of their contact. One also sees the White Rock Escarpment, Mountain Lake, terraces along Mountain Creek and Trinity River, the Trinity Floodplain with its levees, and the plants of two large portland-cement companies.

## FIELD TRIP 1

Begin back of Hyer Hall, Southern Methodist University, and proceed to Airline Road. Mileage is measured from the point of entry to this road. Turn left (north).

**1.40 mi.**—Intersection of Airline Road and Northwest Highway (State Highway 114). Turn right.

**2.20 mi.**—Intersection of State Highway 114 and U. S. Highway 75. From this point the valley of White Rock Creek may be seen ahead in the distance. Continue straight ahead on State Highway 114. Sections of marl and calcareous shale with interbedded chalk, all part of the Austin formation, may be seen along the highway cut at the underpass and in youthful stream valleys crossed by the highway in the next mile.

**3.20 mi.**—In the cuts along the highway at the crest of a rounded hill are sections through a channel-filling that was described by Ham (1941). The filling consists mostly of calcareous clay reworked from the Austin, and contains small caliche nodules.

**3.90 mi.**—At this point the highway begins to descend to the level of a broad flat terrace of White Rock Creek. Sections of the terrace alluvium may be seen to the right of the highway at 4.4 miles, just before the railway overpass is reached. Continue straight ahead past Lawther Drive.

**4.90 mi.**—The highway crosses the delta of White Rock Creek, built at the head of White Rock Lake since 1910, the year that the reservoir was completed. The delta consists of gray to black humic clay and silt. In an effort to convert this swampy tract into grounds suitable for recreational purposes, the muds are being dredged from certain areas and used to fill and elevate others.

**5.40 mi.**—Exposed on the left are interbedded gray calcareous shales and chalky layers, all belonging to the Austin. Numerous fresh nodules of marcasite weather from the shaly beds.

**5.50 mi.**—Intersection of State Highway 114 and Buckner Blvd. Turn right (southeast) and continue on Buckner. From the crest of the first rise there is a good view of White Rock Lake and of the delta at its head. Chalky and marly beds of the Austin crop out in many places along the highway.

**7.90 mi.**—Intersection of Buckner Blvd. and U. S. Highway 67. Continue on Buckner. In small gullies to the right and left of the boulevard, a short distance northwest of the intersection, are good sections of the marly beds that characterize the middle part of the Austin. These marls contain abundant Foraminifera, ostracods, and pelecypods (*Gryphaea aucella* Roemer and *G. wratheri* Stephenson). Good sections of the upper Austin are seen beyond the intersection.

**10.90 mi.**—Fork of road. Take right fork and continue across U. S. Highway 80. The Austin-Taylor contact parallels the boulevard a short distance to the left along the base of a low rise.

**13.30 mi.**—Intersection of Buckner Blvd. with State Highway 183 at Pleasant Mound Church. Turn right (west).

Excellent sections of the upper Austin chalks, marls, and shales are seen along the road for the next mile.

**14.20 mi.**—Lenticular bedding in the Austin is well displayed in the walls of the small quarry to the right of the road.

**14.70 mi.**—Beginning at this point good views of the broad Trinity Valley may be seen to the left. The road descends from the chalky upland onto terraces and leads down into the floodplain of White Rock Creek.

**16.30 mi.**—Cross White Rock Creek and continue on Highway 183.

**17.15 mi.**—Intersection of Highway 183 and Hatcher Street. Take left on Hatcher Street, and continue to the intersection with U. S. Highway 75. In this stretch the road crosses terraces of the Trinity. Reddish alluvium belonging to the terrace deposits may be seen at several places.

**19.10 mi.**—Intersection of Hatcher Street and U. S. Highway 75. Turn left on Highway 75. For approximately the next mile the road follows along the edge of a low terrace.

**20.30 mi.**—The highway crosses the floodplain of the Trinity on a long bridge. Note the numerous sloughs on the floodplain. The river is crossed and the bridge connects at its southeast end with the surface of a terrace.

**21.90 mi.**—Sections through gravel and sand underlying the terrace may be seen to the left of the road at this point. To the right a gentle rise leads up to the level of a higher terrace, preserved as erosional remnants.

**23.15 mi.**—From this point one gets a good view of a timbered rise, down the road and to the right. This higher area is underlain by the Austin chalk.

**23.85 mi.**—The road climbs to a higher terrace, possibly the Travis School level.

**24.55 mi.**—Terrace gravels and sands are seen in the pits to the left of the road. White chalk of the Austin formation is seen along the face of the timbered rise ahead.

**25.75 mi.**—From the top of a hill a good view is had of the terraced Trinity lowland.

**26.75 mi.**—Enter Hutchins. Continue straight through.

**30.95 mi.**—Cross creek. A good exposure of the Austin-Taylor contact is in the ditch to the right of the road directly northwest of the bridge.

**31.30 mi.**—Enter Wilmer. From this point the highway continues for some distance across a broad terrace.

**33.55 mi.**—The road descends from the level of the terrace to the floodplain of Ten Mile Creek.

**34.25 mi.**—Cross Ten Mile Creek. The low bluffs ahead are underlain by the Taylor formation.

**34.95 mi.**—Dallas-Ellis county line. Clay-shale belonging to the Taylor is well exposed in the pit to the left.

## FIELD TRIP 2

Begin in front of main entrance, Union Terminal Station, Dallas and head southeast on U. S. Highway 80 up the ramp that leads to the Oak Cliff Viaduct. Driving across the viaduct one sees down below the floodplain of the Trinity and the levees that confine the river for protection against floods. Against the sky ahead and to the right is the profile of a low escarpment formed by the lower chalky beds of the Austin.

**1.10 mi.**—South end of Oak Cliff viaduct. Continue on Highway 80.

**1.80 mi.**—Pass marker at base of Zangs Crystal Hill. Continue on Zangs Blvd. (U. S. Highway 80).

**2.25 mi.**—Turn right on Davis Street, and continue along U. S. Highway 80.

**4.85 mi.**—Beginning about here good exposures of the Austin chalk may be seen along the highway. Continue on Highway 80.

**6.45 mi.**—At this point and ahead the lowland lying to the west and northwest of White Rock Escarpment may be seen.

**6.95 mi.**—Contact between the Austin chalk and the Eagle Ford shale well exposed in cuts along the side of the highway. Ahead is the Mountain Creek Valley, developed by erosion of the weak Eagle Ford shales. Mountain Lake, formed by damming Mountain Creek, is seen to the southwest. Before crossing the bridge at the base of the hill, turn right on Chalk Hill Road, and continue until the town of Eagle Ford is reached.

Driving along Chalk Hill Road one sees to the right the steep face of White Rock Escarpment, a cuesta formed by differential erosion of the Austin and Eagle Ford formations, and capped by the lower chalky beds of the Austin. To the left are terrace remnants. The large buildings of the Trinity Portland Cement Co. soon come into view on the right.

**8.25 mi.**—From the top of a small rise on Chalk Hill Road the broad floodplain of the Trinity may be seen ahead.

**8.95 mi.**—The town of Eagle Ford. This is the type area for the Eagle Ford formation, as designated by Hill. The shales are exposed in numerous places along the road and in stream cuts, but better sections of the Eagle Ford are to be found in other parts of the county.

**9.05 mi.**—Intersection of Chalk Hill and Eagle Ford roads. Turn right on Eagle Ford Road and follow it back to Dallas. To the right one sees the White Rock Escarpment, and in the distance to the left are the levees on the Trinity floodplain.

**10.45 mi.**—Pass Texas Company refinery. The profile of the White Rock Escarpment is clearly seen against the sky to the right.

**11.25 mi.**—From the top of a small hill are good views of the Trinity Valley and the Dallas skyline ahead. A quarry in the Austin chalk is located at the crest of the hill to the right.

**11.65 mi.**—Workings of the Lone Star Cement Company are seen to the right. The cement companies around Dallas are located on the Austin-Eagle Ford contact, along which the raw materials of shale and limestone that are necessary for making portland cement are most conveniently obtained.

**11.85 mi.**—To the left of the road are gravel pits. Gravel and sand are alluvial deposits of the Trinity River. Continue on Eagle Ford Road.

**13.85 mi.**—Take left, and return to Dallas by Lamar-McKinney viaduct.

# PART III

# *Subsurface Geology*

# GENERAL STATEMENT

Dallas County, not being an oil-producing area, has not attracted much drilling to the present time. Few electrical logs, core records, driller's logs and paleontological reports are available therefore, and a comprehensive report on the subsurface geology of the area is not possible at this time. Most of the logs and other subsurface data presently available for this purpose are reproduced elsewhere in the report.

Wells drilled in Dallas County encounter beds from the Taylor formation of the Upper Cretaceous at the surface to beds believed to belong to the Paleozoic at the total depth of two of the wells. The intervening strata encountered in these wells are shown in the columnar section on Plate III.

The Eagle Ford, Austin and Taylor formations have been described in the section on surface geology. Since these beds are very similar in the subsurface to the outcropping section, no subsurface description is included here.

# CRETACEOUS ROCKS

## WOODBINE FORMATION

The Woodbine formation in the Dallas County area is a sequence of sandstones, sandy shales, and shales. The sandstones are generally ferruginous and quite porous. Individual beds very greatly in thickness and do not extend as continuous, recognizable units over wide areas. This feature is well-illustrated by the Schlumberger electrical logs on plate II. It is also characteristic of the Woodbine in other areas. The total amcunt of sand in this part of the section is also variable. The Schlumberger electrical log of the North American Aviation No. 1 Water Well shows 124 feet of relatively clean sand in a total section of 444 feet, making the sand content of the Woodbine in this area approximately 28 percent. The Lane-Texas Company No. 2 City of Mesquite Water Well, on the other hand, shows 288 feet of sand in a total section of 412 feet, which is 69 percent. For certain reasons the electrical log of the latter well is difficult to interpret, making possible a considerable error in this determination. It is certain, however, that the sand content the Woodbine consists of rather fine-grained sands and sandy clays, which are sometimes calcareous or glauconitic. These beds grade downward into a zone of sandy clays, siltstones, bentonitic clays, thin beds of valcanic ash and sands that are gray, purplish and reddish in the unweathered state. The lower part of the Woodbine is also sandy but contains much less volcanic material than the rest of the formation. It has also lost the purple and red shales which characterize the upper part.

The prominence of sandstone beds in the Woodbine distinguishes it from the overlying Eagle Ford formation in the subsurface section, excepting in those areas where the Eagle Ford is sandy in its basal part. The Woodbine crops out immediately west of Dallas County in an area known, physiographically, as the "Eastern Cross Timbers". It wedges out on the east side of the East Texas basin against the west flank of the Sabine uplift where the great East Texas oil field is located.

The basal contact of the Woodbine is along an unconformity. This is an important hiatus in the Dallas County section and marks the contact between the Upper Cretaceous and the Lower Cretaceous.

This formation is very important economically. It is petroliferous in the East Texas basin and may produce more oil than any other formation in the United States. In the vicinity of Dallas County, however, it is important only as a supply of water. The water derived from the Woodbine in Dallas County is potable. Lower sands of the formation generally furnish water of better quality than is found in the upper part. Plummer and Sargent (1931) state that the total solids, which were computed in 11 analyses, ranged in amounts from 1,191 to 2,468 parts per million. In the analyses available to them on 30 water wells producing from the Woodbine, the several constituents, measured in parts per million, are as follows:

| | | | |
|---|---|---|---|
| Ca | 4 | to | 16 |
| Mg | 1 | to | 92 |
| Na | 271 | to | 930 |
| $HCO_3$ | 483 | to | 1,002 |
| $SO_4$ | 183 | to | 687 |
| Cl | 27 | to | 665 |

### WASHITA AND FREDERICKSBURG GROUPS

The Washita and Fredericksburg groups cannot at the present time be distinguished satisfactorily in the Dallas County subsurface section. The Grayson limestone, the uppermost formation of the Washita group, has been identifield in a number of wells in Dallas County, and the Buda limestone and Del Rio clay have been identified in the W. E. Butler *et al.* No. 1 A. M. Sims well located in Ellis County near the southeast corner of Dallas County. Detailed studies of this part of the section in a few other wells have also been made in the Dallas County area, but it cannot be said at this time that the various subdivisions of the Washita and Fredricksburg groups recognizable in the outcropping area can be satisfactorily identified in the Dallas County subsurface section.

Calcareous deposits predominate in the Washita and Fredericksburg groups beneath Dallas County. Although pure limestones are difficult to distinguish from marls in electrical logs, it is probable that the former comprise 35 percent or more of the total section. The remainder is calcareous shale and calcareous clay, which, broadly speaking, may be classified as marls. Analyses of sample cuttings indicate total thicknesses of the Washita and Fredericksburg groups in Dallas County varying between 520 and 715 feet. Present interpretation of the Schlumberger electrical logs of the W. E. Butler *et al.* No. 1 A. M. Sims well indicates a thickness of 772 feet for these groups in that area.

The Washita and Fredericksburg groups crop out west of Dallas County in Tarrant and Parker Counties in an area known physiographically as the "Grand Prairie". The basal contact of the Fredericksburg is conformable although a hiatus of some consequence appears, probably due to the nature of lithologic changes in the section at this point.

## TRINITY GROUP

The Trinity group is divided into three formations, which, in descending order, are the Paluxy, Glen Rose and Travis Peak. The upper and lower formations are predominantly sandstones while the intervening strata are largely calcareous. The Trinity group rests unconformably on beds which are believed to be of Paleozoic age.

### PALUXY FORMATION

Sandstones predominate in the Paluxy formation, but many shale beds are also present. The sandstones are quartzose and porous, and the shales are characteristically calcareous and light-colored. Although there is only one electrical log for wells penetrating the Paluxy in Dallas County, many are available in other areas. These logs show that individual sandstone beds vary greatly in thickness and are not continuous over wide areas. It is estimated that sandstones constitute two-thirds to three-fourths of the entire formation. It has a thickness of approximately 150 feet in the Dallas County area.

The Paluxy can be distinguished in subsurface from the overlying Fredericksburg by the absence of pure limestone strata. In some places, however, the basal part of the overlying beds is sandy. The basal contact of the Paluxy is conformable.

This formation has no economic value in Dallas County, but is oil-bearing elsewhere in Texas, notably in the Talco and Sulphur Bluff fields of Titus, Franklin and Hopkins counties. The crude from these fields is characteristically dark in color, low in gravity, low in gasoline content and has an asphaltic base. It is used for road material.

### GLEN ROSE FORMATION

The Glen Rose formation is a thick sequence of limestone, calcareous clays, and calcareous shales. The limestones are thin-to-medium-bedded and are predominant in this part of the section. Anhydrite has been reported in the cuttings from some wells. Anhydrite is a characteristic feature of the middle part of the Glen Rose in Louisiana and Arkansas, and this feature may well be present in the vicinity of Dallas County. The lower part of the formation is sandy, making a gradational and conformable contact with the underlying Travis Peak formation. The Glen Rose varies in thickness from approximately 470 feet in the Mark Raley No. 1 R. S. Morris well located south of Grand Prairie to 1,014 feet in the W. E. Butler *et al.* No. 1 A. M. Sims well in Ellis County. The latter thickness is by electrical log interpretation.

Although the Glen Rose produces in many fields in northern Louisiana, southern Arkansas and eastern Texas, it is of no importance economically in Dallas County.

#### TRAVIS PEAK FORMATION

The Travis Peak formation is composed of alternating beds of sandstone and shale. The sandstones are quartzose and vary in color from gray to red. The shales are multicolored, reds, blues, and grays being conspicuous. At its base, the formation is conglomeratic. Since arenaceous sediments predominate, the Travis Peak is sometimes known as the "Basal Trinity Sands". It is between 440 and 490 feet thick in the Mark Raley No. 1 R. S. Morris well south of Grand Prairie. Wells in the eastern part of the county have not penetrated entirely through the formation, but it is probably thicker here than on the west side of the county. The Travis Peak crops out west of Dallas County in western Parker County in an area known physiographically as the "Western Cross Timbers".

The basal contact of this formation is marked by a major unconformity. This is the greatest hiatus yet encountered by drilling in Dallas County. In the Mark Raley No. 1 R. S. Morris well and probably in the Mauldin Oil Company No. 1 W. E. Howell well, the base of the Travis Peak rests on beds which are believed to be of Paleozoic age. This hiatus thus represents all of Jurassic and Triassic time and part of Paleozoic time. In some other parts of Texas, the Trinity rests directly on the pre-Cambrian, the entire Paleozoic being absent.

The Travis Peak together with the overlying Glen Rose and Paluxy comprise an interesting stratigraphic unit. The sequence rests on a major unconformity and begins with a basal conglomerate in the lower Travis Peak, grading upward in the same formation into sandstone and shales, then into sandy marls and pure limestones in the Glen Rose, finally culminating in the sandstones and shales of the Paluxy.

## PALEOZOIC ROCKS

Below the Trinity beds of the Cretaceous in Dallas County lie dark shales which are considered Paleozoic in age. There are insufficient data to determine more precisely the age of these deposits. Some core descriptions state that the shales are very hard and dark, others soft and waxy. The hard shales contain structures which may either be fault surfaces or slaty cleavage. It is thus possible that we are here dealing with partly metamorphosed sediments.

## LOGS AND CORE RECORDS OF WELLS IN DALLAS COUNTY

**COMPANY: Alford, J. B.**
**LESSOR: McCoy, W. W., Well No. 1**
**LOCATION: Approx. 660′ to E line & 330′ to S line of John Jackson Sur.**

| | |
|---|---|
| 0-30 | Surface |
| 55 | Shale |
| 105 | Shale and shells |
| 150 | Shale |
| 235 | Shale |
| 315 | Shale |
| 392 | Shale and boulders |
| 395 | Sandy lime shell |
| 400 | Lime rock |
| 402 | Lime rock |
| 412 | Water sand |
| 435 | Sticky shale |
| 460 | Shale |
| 470 | Sand |
| 490 | Shale |
| 500 | Sand |
| 530 | Sand and shale |
| 560 | Sand |
| 568 | Gumbo |
| 570 | Lime and shell |
| 572 | Gypsum |
| 574 | Boulders and shale |
| 580 | Sand |
| 604 | Shale |
| 624 | Sticky shale |
| 650 | Shale |
| 660 | Pay sand |
| 674 | Shale |
| 690 | Broken lime |
| 700 | Hard lime |
| 710 | Lime |
| 725 | Sticky shale |
| 750 | Sticky shale |
| 760 | Sticky shale |
| 775 | Sticky shale |
| 776 | Lime |
| 782 | Lime rock |
| 783 | Lime |
| 791 | Sticky shale |
| 796 | Sticky shale |
| 802 | Lime |
| 807 | Lime |
| 835 | Shale |
| 840 | Lime |
| 842 | Lime |
| 880 | Shale and lime shells |
| 881 | Lime rock |
| 887 | Lime rock |
| 893 | Lime |
| 953 | Lime |
| 956 | Lime |
| 963 | Lime rock |
| 970 | Lime |
| 974 | Broken lime |
| 978 | Sandy lime |
| 983 | Shale and sand |
| 988 | Broken lime |
| 998 | Shale |
| 1002 | Lime rock |

1008 Lime
1023 Sandy shale and boulders
1024 Sand
1025 Shale and sand
1035 Lime rock
1038 Sand and broken lime
1057 Sand and broken lime
1063 Shale
1065 Sandy lime
1075 Lime rock
1086 Sandy lime
1106 Lime
1112 Gumbo
1115 Gumbo
1126 Sticky shale
1128 Lime rock
1136 Lime rock
1151 Lime rock
1159 Lime
1173 Lime
1198 Lime, sand and shale, Chalk A
1200 Lime
1207 Lime
1218 Hard sand
1226 Hard sand
1228 Sand
1229 Sand
1239 Gumbo
1267 Sticky shale
1268 Sand
1281 White sand
1288 Hard sand
1292 Sand (Core)
1322 Sticky shale and boulders
1333 Sticky shale and boulders
1344 Sandy shale
1348 Sand
1353 Blue shale
1356 Sand (Core)
TOTAL DEPTH

**Core Record**

1008-1009 Sand and shale
1024-1025 Shale and sand
1115-1126 Shale
1250-1251
1344-1345

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**COMPANY: City of Highland Park**
**LESSOR: Pump Station, Well No. 3**
**LOCATION: Approx. 1000′ SE & 75′ NE of N corner of Wm. Grigsby Sur. in John Cole Sur. No. 25-C.**
CSG. RECORD:
400′ of 22″ ID sheet csg.
400′ to 1568′ of 12½″ soft csg. Top Paluxy
1568′ to 1733′ of 10″ perforated liner

**Deepened at 1740′**
8¼″—2560′ 100 sx. Portland Cement
TD 2865′ 305′—8″
Set 354′ of 6″ 23½′ wrought iron liner 314′ of which was perforated.

0 - 6 Clay
171 White rock
239 Blue shale
330 Blue shale and marl
368 Shale
367 Rock
500 Shale
593 Shale and marl
602 Sandy shale
684 Sand rock
767 Shale and rock
794 Sand rock
585 Sandy shale
868 Sand rock
908 Sandy shale
926 Hard sand and sand rock
957 Hard. water sand and sand rock
974 Shale and gumbo
1050 Shale and lime rock
1056 Sand and lime rock
1091 Lime rock
1122 Shale and lime rock
1141 Limestone rock
1149 Shale and marl
1170 Lime rock
1249 Marl and lime rock
1435 Lime rock
1448 Shale and lime rock
1556 Lime rock
1571 Shale
1580 Lime and sand rock
1586 Shale and soapstone
1617 Sand
1630 Sandy shale
1644 Shale and lime rock
1677 Water sand
1727 Sand
1733 Sandy lime rock
1740 Lime rock
1804 Brk. lime
1810 Hard lime
1938 Brk. lime
1948 Lime rock
1971 Brk. lime
1993 Lime
2021 Lime rock

2049 Brk. lime
2096 Hard lime
2111 Lime rock
2119 Hard lime
2133 Lime rock
2175 Hard lime
2195 Brk. lime
2236 Hard lime rock
2253 Sandy lime
2349 Hard sand
2358 Sharp sand
2362 Sand
2380 Sandy lime
2393 Lime and strks. sand
2418 Sandy lime sand
2447 Lime, hard sand, hard lime
2455 Hard lime
2458 Hard sand rock
2474 Hard rock, lime rock
2515 Hard lime
2534 Red bed
2544 Red bed, sand, red bed
2560 Red bed gumbo
2563 Red bed
2609 Red bed, streaks of sand
2611 Hard lime
2619 Red bed
2635 Red bed, hard sand
2810 Sand
2822 Hard sand
2841 Sand, hard sand rock, lime
2863 Sand streaks, hard lime
2875 Hard, sandy lime
TOTAL DEPTH

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**COMPANY: City of Highland Park**
**LESSOR: Dallas Country Club Well No. 2**
**COMP.: July 1923**
**LOCATION: Approximately 1,250′ E & 200′ S of SW corner of J. Scurlock Sur. in John Cole Sur. No. 25-C.**
**ELEVATION: 510′ U. S. G. S.**
CSG. RECORD: 8¼″—2570′
0 - 7 Surface
113 White rock
353 Shale
453 Gumbo
572 Shale
632 Rock
644 Pyr. sand and shale
664 Soapstone
694 Shale
707 Soapstone
767 Sand shale
781 Soapstone and sand
791 Shale
801 Soapstone
821 Hard sand rock
841 Sand
871 Shale
881 Gumbo
891 Soapstone
906 Sand
996 Hard sand
1016 Shale
1036 Lime rock
1066 Shale and blds.
1193 Lime
1219 Gumbo
1235 Lime
1237 Gumbo
1264 Brk. lime
1326 Lime
1348 Brk. lime
1370 Lime
1388 Brk. lime
1405 Lime rock
1424 Lime
1446 Lime rock
1452 Shale
1461 Lime rock
1463 Lime
1470 Hard lime
1484 Lime
1491 Hard lime
1521 Lime
1526 Shale and blds.
1543 Lime
1549 Shale
1551 Lime
1601 Sand
1603 Gumbo
1609 Red gumbo
1637 Brk. sand
1642 Red gumbo
1646 Hard rock
1647 Hard sand
1676 Sand and shale
1695 Sand
1697 Sand rock
1704 Hard sand
1707 Rock
1726 Lime rock
1743 Hard lime rock
1787 Brk. lime rock
1791 Hard rock
1802 Hard lime rock
1822 Brk. lime
1826 Hard lime
1835 Brk. lime
1838 Hard lime
1869 Brk. lime

| | |
|---|---|
| 1873 | Hard lime |
| 1903 | Brk. lime |
| 1925 | Hard lime |
| 1927 | Sand rock |
| 1928 | Hard sand rock |
| 1939 | Hard lime |
| 1988 | Lime rock |
| 1992 | Brk. lime |
| 1997 | Lime |
| 2038 | Lime rock |
| 2073 | Brk. lime |
| 2110 | Lime rock, hard |
| 2112 | Soapstone |
| 2128 | Lime rock |
| 2170 | Brk. lime |
| 2190 | Lime rock |
| 2209 | Brk. lime |
| 2219 | Lime rock |
| 2245 | Hard lime |
| 2252 | Sandy lime |
| 2257 | Hard lime |
| 2264 | Sandy lime |
| 2272 | Sandy lime |
| 2281 | Hard sand |
| 2292 | Sand |
| 2300 | Hard sand |
| 2308 | Sand |
| 2315 | Hard sand |
| 2322 | Sand |
| 2328 | Hard sand |
| 2342 | Sand |
| 2362 | Hard sand |
| 2377 | Red mud, little streaks of sand |
| 2395 | Red mud, streaks of sand |
| 2404 | Red bed, sandy lime |
| 2405 | Hard lime |
| 2408 | Hard sand rock |
| 2417 | Hard sand |
| 2456 | Sand rock |
| 2461 | Pyrites, sand rock |
| 2463 | Sand rock |
| 2465 | Very hard lime |
| 2472 | Lime rock |
| 2476 | Sand rock |
| 2487 | Sandy lime |
| 2526 | Lime rock |
| 2534 | Red bed, lime rock |
| 2542 | Lime rock |
| 2566 | Red bed |
| 2572 | Red bed sand |
| 2592 | Red bed and brk. sand |
| 2652 | Red bed and sand |
| 2657 | Hard sand |
| 2666 | Sand rock |
| 2688 | Red bed and sand |
| 2705 | Sand |
| 2724 | Red bed, hard sand |
| 2739 | Hard sand, red bed |
| 2750 | Red bed, hard sand |
| 2757 | Hard sand |
| 2770 | Sand |
| 2782 | Hard sand |
| 2823 | Water sand |
| 2829 | Hard sand |
| 2841 | Lime rock, sand |
| 2843 | Hard sand rock |
| 2851 | Hard sand rock, rock bit |
| 2860 | Sand |
| 2861 | Hard, red pyrites |
| | TOTAL DEPTH |

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**COMPANY: Dearing, R. A., and Sons**
**LESSOR: Buckner's Orphan Home Well No. 1**
**COMM.: 5-10-25**
**COMP.: 9-21-25**
**LOCATION: 7 miles E of Dallas. Approx. 250′ to N line & 250′ to E line of David Badgley Sur. No. 197-C.**

| | |
|---|---|
| 0 - 8 | Surface soil |
| 513 | Chalk |
| 760 | Shale |
| 795 | Gumbo |
| 1123 | Shale |
| 1134 | Sand rock |
| 1135 | Hard rock |
| 1160 | Shale and soapstone |
| 1180 | Gumbo |
| 1200 | Shale and soapstone |
| 1255 | Sand and hard shale |
| 1312 | First Woodbine sand |
| 1422 | Redbed and sandy shale |
| 1472 | Second Woodbine sand |
| 1480 | Lime |
| 1537 | Redbed, lime and shale |
| 1581 | Sand and lime |
| 1635 | Hard lime |
| 1665 | Gumbo and lime |
| 1710 | Hard lime |
| 1734 | Gumbo |
| 2087 | Hard lime with streaks of gumbo |
| 2102 | Broken sand and shale |
| 2148 | Broken sand and lime |
| 2163 | Redbed and soapstone |
| 2193 | Sand |
| 2203 | Gumbo and hard lime |
| 2300 | Paluxy sand |
| 2331 | Lime |
| 2336 | Hard sand rock |
| 2362 | Sandy lime |
| 2628 | Hard lime |

2792 Glenrose sand with thin streaks of redbed
2824 Hard broken lime
2845 Broken sand
2887 Hard broken lime
2910 Broken sand
2938 Lime and redbed
2975 Redbed
3075 Very hard sandy lime; Top of Trinity sand
3313 Trinity sand with thin streaks of redbed
3327 Hard lime and gravel
3361 Trinity sand
3368 Gravel and soapstone
TOTAL DEPTH

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**COMPANY: Dallas City Water Works**
**LESSOR: Stevens Park**
**Well No.: 38**
**COMM.: 10-12-30**
**COMP.: 12-27-30**
**LOCATION: Approx. 2,550′ to N line & 200′ to E line of Anson McCracken Sur. No. 10-C.**
**ELEVATION: 495′**

0-14 Surface soil
127 Blue shale
175 Shale and shell rock
515 Shale
539 Sand
660 Shale and shell rock
665 Broken limestone
705 Woodbine sand
760 Shale
775 Sandstone
810 Broken sandstone
909 Shale and lime shell
954 Limestone
983 Shale
1419 Limestone
1456 Broken limestone and sand
1472 Sand
1491 Gumbo clay
1501 Sand
1503 Gumbo clay
1531 Sand
1549 Broken sandstone
1575 Sand
1598 Shale and limestone
1633 Limestone and sand
1636 Shale
1691 Limestone and sand
1724 Limestone and shale
1810 Limestone
1880 Limestone and shale
1965 Shell rocks and sand
2005 Sand and shale
2052 Limestone and sand
2130 Limestone and shale
2169 Sand
2203 Sand and shale
2204 Gumbo clay
2226 Sand and shale
2238 Gumbo clay and hard sand
2284 Sand and shale
2292 Red bed
2296 Shale, limestone and red bed
2314 Red beds
2348 Sand
2362 Red beds
2521 Sand
2526 Broken sandstone
2576 Broken sand and shell rocks
2634 Shale and lime shells
TOTAL DEPTH

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**COMPANY: Dallas City Water Works**
**LESSOR: Gillum & Norte**
**Well No. 37**
**COMM.: 2-16-30**
**COMP.: 4-21-30**
**LOCATION: Approx. 330′ to N line & 330′ to E line of John P. Narbroe Sur. No. 51-C.**
**ELEVATION: 547′**

0 - 5 Surface soil
222 White rock
681 Shale and shells
694 Sand
708 Hard sand
713 Sand
791 Shale
823 Sand
874 Sandy shale
904 Woodbine sand
910 Sand
995 Shale and rocks
1000 Sand and rocks
1030 Hard shale and shells
1124 Shale and limestone
1155 Broken limestone and marl
1263 Limestone
1276 Shale
1323 Limestone
1353 Limestone and marl
1424 Limestone
1459 Limestone and marl
1554 Limestone
1595 Limestone and sand
1637 Sand

| | |
|---|---|
| 1711 | Water sand |
| 1741 | Shale and rock |
| 1783 | Broken limestone and sand |
| 1847 | Limestone |
| 1859 | Gumbo |
| 1874 | Shale |
| 1886 | Limestone |
| 1924 | Sandy limestone (Glenrose) |
| 1963 | Limestone and marl |
| 1981 | Limestone |
| 1994 | Limestone and marl |
| 2037 | Shell rock and sand |
| 2040 | Limestone |
| 2046 | Sand |
| 2104 | Limestone |
| 2146 | Broken sand and limestone |
| 2183 | Broken limestone |
| 2224 | Broken sand and limestone |
| 2246 | Broken sand and shale |
| 2282 | Sandy limestone and sand |
| 2297 | Limestone |
| 2336 | Sandy limestone, sand and marl |
| 2389 | Shell and sand |
| 2424 | Sandy limestone and shell |
| 2472 | Sandy limestone, sand and marl |
| 2480 | Red bed |
| 2482 | Shale |
| 2491 | Sandy limestone |
| 2495 | Marl |
| 2501 | Shale and rock |
| 2513 | Sandy limestone |
| 2536 | Sand |
| 2556 | Sand |
| 2588 | Sand and red bed |
| 2606 | Red bed |
| 2616 | Sand |
| 2671 | Broken sand and red bed |
| 2834 | Sand |
| 2918 | Broken sand and red bed |
| 2921 | Shale |
| 2922 | Hard rock |
| | TOTAL DEPTH |

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**COMPANY: Layne Texas Company**
**LESSOR: North American Aviation, Inc. Well No. 2**
**COMM.: 1-16-41**
**COMP.: 2-5-41**
**LOCATION: Hugh N. Fitzgerald (or sometimes known as Edward Cane farm) in P. Linney survey. Abstract No. 777.**
**ELEVATION: 500′**
CSG. RECORD: 11¾″ to 1879′; 9⅝″ to 2152′

| | |
|---|---|
| 0 - 4 | Rotary to Ground |
| 8 | Soil |
| 15 | Yellow clay |
| 65 | Sandy clay and sand |
| 118 | Hard sandy shale |
| 168 | Shale |
| 169 | Sand rock |
| 188 | Sand |
| 268 | Hard shale |
| 274 | Sand |
| 278 | Rock |
| 300 | Sand and lignite |
| 342 | Shale |
| 357 | Sand |
| 365 | Shale |
| 379 | Shale and sand |
| 480 | Sandy shale and shale |
| 523 | Shale |
| 566 | Hard shale and lime |
| 614 | Shale and lime |
| 968 | Lime |
| 998 | Lime and shale |
| 1023 | Sandy shale and sand |
| 1025 | Hard shale |
| 1032 | Sandy shale and sand |
| 1061 | Sand |
| 1085 | Hard red shale and lime |
| 1138 | Sandy lime and shale |
| 1180 | Sandy shale and lime |
| 1206 | Sandy lime |
| 1249 | Lime and shale |
| 1310 | Sandy shale and thin layers hard sand |
| 1363 | Sandy lime and shale |
| 1383 | Lime and shale |
| 1407 | Lime |
| 1430 | Lime |
| 1440 | Sandy lime |
| 1454 | Lime |
| 1487 | Lime |
| 1527 | Lime and layers shale |
| 1563 | Lime and layers shale |
| 1595 | Shale and lime |
| 1635 | Shale and lime |
| 1650 | Shale and lime |
| 1656 | Shale |
| 1700 | Sand |
| 1710 | Lime |
| 1716 | Sand |
| 1747 | Lime and shale |
| 1762 | Lime and shale |
| 1783 | Shale and lime |
| 1791 | Sand |
| 1807 | Shale and lime |
| 1830 | Hard red and blue shale |
| 1840 | Sand |
| 1847 | Shale |
| 1879 | Hard blue and red shale |

1907 Hard red and blue shale
1921 Sand
1925 Hard shale
1932 Hard shale
1943 Sandy lime and layers sand
1955 Hard shale
1970 Sand
1977 Shale
1990 Hard shale and layers sand rock
2066 Sand
2074 Lime
2084 Sand
2152 Hard shale and layers lime
TOTAL DEPTH

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**COMPANY: Layne-Texas of Houston**

**LESSOR: Fed. Women's Pen. Well No. 1**

**LOCATION: 50′ SW of NEL (rr right-of-way) and approximately 700′ SE of NWL of 14.3 ac. tract. formerly H. B. Lowe. 1 mile NW of Seagoville.**

**ELEVATION: 434′**

0-12 Surface
20 Sandy clay
44 Red clay
73 Hard broken shale
180 Taylor marl
360 Taylor marl
386 Hard shale and chalk
940 Chalk
1450 Shale
1457 Shale and thin stks. sand
1505 Shale and stks. sandy shale
1546 Shale
1585 Sand
1610 Sandy shale and red stky. shale
1675 Sandy shale and stks. sand
1681 Sand
1704 Hard sandy shale
1737 Sand
1748 Hard shale
1775 Sandy shale and stks. sand
1793 Sandy shale and stks. sand
1806 Hard shale
1843 Sand and stks. shale
1850 Shale and lime
TOTAL DEPTH 1850′

**COMPANY: Magnolia Petroleum Co.**
**LESSOR: Fee Well No. 1**
**LOCATION: Magnolia Petroleum Company Building, 1415 Commerce St., Dallas, Texas**
CSG: 20″—16′
13¼″—358′
8¼″—1513′
0 - 8 Surface
91 Chalk rock
122 Gumbo
128 Sand
166 Gumbo
255 Shale
261 Lime rock
380 Gumbo
593 Shale
607 Sand, lime mixed
622 Shale
629 Sand rock
702 Shale, sand, shells
717 Sand, lime mixed
761 Shale, sand, shells
815 Sand, Woodbine
864 Gumbo shale
920 Shale, sand, shells
1040 Gumbo
1154 Lime rock
1180 Shale
1320 Lime rock
1342 Gumbo
1476 Lime
1488 Shale
1502 Lime rock
1511 Gumbo
1516 Sand rock
1530 Sand
1538 Shale
1586 Sand
1594 Gumbo
1632 Sand
1637 Shale
1668 Sand, lime

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**COMPANY: Mathews, D. C.**
**LESSOR: Seaton, W. W. Well No. 1**
**COMM.: 1-1-28**
**COMP.: 7-20-28**
**LOCATION: 500′ from EL, 300′ from SL of 174 acre tract, in SW corner of county. J. G. Garrett survey.**
0-20 Surface clay
190 Shale
207 Woodbine sand (Cored)

| | |
|---|---|
| 211 | Shale |
| 245 | Sand |
| 250 | Shale |
| 265 | Sand |
| 270 | Shale |
| 290 | Sand (Cored) |
| 351 | Sand |
| 373 | Sand |
| 384 | Shale |
| 385 | Shale |
| 442 | Sand (Cored) |
| 537 | Shale |
| 575 | Lime |
| 595 | Shale |
| 610 | Lime |
| 617 | Shale |
| 637 | Lime |
| 660 | Shale |
| 800 | Lime |
| 808 | Shale |
| 827 | Lime |
| 830 | Shale |
| 850 | Lime |
| 854 | Shale |
| 872 | Lime |
| 785 | Shale |
| 908 | Lime |
| 912 | Shale |
| 925 | Lime |
| 938 | Brown gumbo |
| 947 | Limey shale |
| 956 | Shells, gas |
| 968 | Black speckled lime |
| 975 | Dry sand (Cored) |
| 980 | Shale |
| 982 | Cap rock |
| 1043 | Paluxy sand (Cored) |
| 1044 | Lime rock |
| 1080 | Sand with lime rock |
| 1086 | Green marl |
| 1140 | Lime |
| 1145 | Shale |
| 1210 | Speckled lime (Cored) |
| 1245 | Lime |
| 1255 | Sandy shale |
| 1280 | Lime, small shells |
| 1286 | White gummy shale |
| 1316 | Sandy lime, gas (cored) |
| 1316½ | Red sandy shale rock |
| 1332 | Sandy lime, sulphur odor stoned pyrites (Cored) |
| 1380 | Lime |
| 1440 | Lime, shells (Cored) |
| 1480 | Lime |
| 1500 | Black slate with lime shale |
| 1503 | Black shale |
| 1515 | Lime oyster shells (Cored) |
| 1545 | Broken shale, sandy lime |
| 1555 | Hard lime, shells |
| 1562 | Sandy shells (Cored) |
| 1580 | Lime, shells |
| 1600 | Hard sandy lime, shale, stoned Pyrites (Cored) |
| 1627 | Mixed black brown shells and sand rock |
| 1630 | Sand rock |
| 1643 | Trinity sand (Cored) |
| 1655 | Gray gumbo |
| 1672 | Sand, mixed with green shale. Cored fine sand |
| 1685 | Pink gray gumbo |
| 1690 | Pack sand (Cored) |
| 1708 | Mixed lime, shells, pyrites |
| 1712 | Sand with green shale (Cored) |
| 1725 | Red shale and sand |
| 1740 | Red shale |
| 1763 | Mixed sand, lime and shale |
| 1773 | Mixed lime, sand and shale (Cored) |
| 1963 | Mixed sands, redbeds, shale breaks and Trinity sand |
| 1969 | Sand (Cored) |
| 1973 | Shale |
| 1980 | Lime, shale |
| 1986 | Blue shale, redbed (Cored) |
| 1995 | Lime |
| 2002 | Lime, sand and redbed |
| 2011 | Dry sand |
| 2016 | Lime |
| 2025 | Redbed |
| 2028 | Sand |
| 2031 | Blue shale |
| 2041 | Lime |
| 2044 | Redbed sand |
| 2047 | Sand |
| 2062 | Sand, black shale |
| 2067 | Lime |
| 2071 | Sand (Cored) |
| 2083 | Sand, shale |
| 2094 | Shale |
| 2198 | Mixed shale, lime |
| 2222 | Black shale |
| 2245 | Sticky shale |
| 2410 | Black shale |
| 2419 | Lime |
| 2432 | Brown shells, sticky; gas |
| 2435 | Lime, shale, oil showing Cored black shale |
| 2470 | Black shale |
| 2483 | Sticky shale |
| 2487 | Lime |
| 2500 | Black sticky shale |
| 2535 | Black shale |
| 2656 | Slaty shale (Cored) |
| 2659 | Gumbo |
| 2660 | Slate |
| | TOTAL DEPTH |

**COMPANY: Mauldin Oil Co.**
**LESSOR: Howell, W. E., Well No. 1**
**LOCATION: Approximately 690' FWL and 1000' FSL of the S. Layton survey. Approximately center of 107.7-acre tract. Two miles SE of Coppell.**
**CSG RECORD: 10"-40'**
**ELEVATION: 530' A.**
**This log is questionable.**

| | |
|---|---|
| 0-40 | Surface clay |
| 245 | Eagleford shale |
| 250 | Cap rock |
| 278 | Sand |
| 280 | Cap rock |
| 295 | Sand |
| 300 | Shells |
| 348 | Shale |
| 350 | Lime shells |
| 360 | Sand |
| 520 | Sandy shale |
| 622 | Hard lime |
| 670 | Shale and lime |
| 690 | Lime |
| 700 | Broken, sandy lime (show gas) |
| 795 | Shale and lime (show gas) |
| 820 | Shale |
| 825 | Lime |
| 830 | Shale |
| 845 | Lime |
| 860 | Shale |
| 895 | Lime |
| 898 | Shale |
| 990 | Shale and lime (Top Paluxy?) |
| 1010 | Sand |
| 1050 | Shale |
| 1060 | Sand |
| 1080 | Shale |
| 1095 | Lime |
| 1300 | Shale |
| 1355 | Lime |
| 1415 | Shale |
| 1425 | Lime and sandy lime (show gas) |
| 1500 | Shale |
| 1530 | Broken lime and shale |
| 1555 | Shale |
| 1590 | Lime |
| 1680 | Shale |
| 1685 | Lime |
| 1703 | Shale and gumbo |
| 1750 | Broken lime (Top Trinity?) |
| 1780 | Dry sand |
| 1790 | Shale and lime |
| 1850 | Dry sand |
| 1885 | Shale |
| 1975 | Lime and shells (Upper Pennsylvanian?) |
| 2000 | Shale |
| 2035 | Lime |
| 2100 | Broken lime |
| 2190 | Hard lime and shells (show gas at 2140') |
| 2210 | Unconformity |
| 2230 | Broken lime (Pennsylvanian?) |
| 2250 | Shale |
| 2295 | Sand and lime |
| 2342 | Hard lime |
| 2350 | Broken lime (show gas) |
| 2390 | Hard lime |
| | TOTAL DEPTH 2510'; lime |

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**COMPANY: Paris Oil Co.**
**LESSOR: Marks, D.D., Well No.1**
**COMM. 8-16-29**
**LOCATION: 1½ miles south of Mesquite. A. Chumley survey, 150' N of C. H. Cole's NL, 450' W of WL of Rockhold 87-acre tract.**
**ELEVATION: 450'**

| | |
|---|---|
| 0-5 | Top soil |
| 23 | Yellow clay |
| 30 | Gray sand |
| 176 | Blue shale, Taylor marl |
| 380 | Hard, white rock, Austin Chalk |
| 407 | Blue, sandy shale |
| 485 | Gray shale |
| 511 | Gray marl |
| 610 | Gray shale |
| 690 | Eagle Ford shale |
| 700 | Gray shale |
| 705 | Sandy shale, small amount of salt water |
| 730 | Soft, gray shale |
| 800 | Blue shale |
| 832 | Black shale, very cavey |
| 900 | Black shale |
| 1001 | Black, soft, cavey shale |
| 1009 | Blue lime with shells |
| 1012 | Blue shale |
| 1018 | Gray lime |
| 1025 | Gray shale |
| 1033 | Brown sand |
| 1250 | Blue shale |
| 1330 | Black shale |
| 1332 | Water sand |
| | TOTAL DEPTH |

**COMPANY: Raley, Mark**
**LESSOR: Morris, R. S.**
**Well No. 1**
**LOCATION: 2 miles S of Grand Prairie 1291' from NL and 1483' from WL of C. Gibbs survey. Abstract No. 47-D.**
**ELEVATION: 488'**

| | |
|---|---|
| 0-21 | Surface |
| 92 | Sandy clay |
| 260 | Shale and shells |
| 282 | Black shale |
| 287 | Soft shale |
| 340 | Shale and shells |
| 355 | White water sand |
| 373 | Shale and shells |
| 390 | Shale and shells |
| 465 | Flakey white lime |
| 490 | Black shale |
| 530 | White lime |
| 558 | Shale and shells |
| 595 | Shale and shells |
| 618 | White lime |
| 675 | Shale and shells |
| 686 | White lime |
| 746 | Shale and shells, grey |
| 950 | Shale and streaks sand |
| 975 | White sand |
| 983 | Sandy shale |
| 997 | Lime |
| 1030 | Soft white sand |
| 1045 | Shale and shells |
| 1140 | Grey lime |
| 1195 | Shale and shells, streaks sand |
| 1215 | Shale and shells |
| 1255 | Lime and white sand |
| 1290 | Blue shale |
| 1304 | White lime |
| 1410 | Shale and shells |
| 1440 | Sand and shale |
| 1496 | Shale, lime and sand |
| 1530 | Sand and shale |
| 1620 | Shale and shells |
| 1650 | White sand |
| 1661 | Shale and sand |
| 1678 | Redbeds |
| 1708 | Shale and sand |
| 1737 | Redbeds |
| 1747 | Blue shale and sand |
| 1767 | Sand and shale |
| 1785 | Lime |
| 1888 | Sand and shale |
| 1948 | Sand and shale |
| 1974 | Hard white lime |
| 2033 | Hard lime |
| 2035 | Hard lime |
| 2073 | Shale |
| 2076 | Shale |
| 2127 | Lime and shells |
| 2147 | Shale |
| 2165 | Hard shale |
| 2220 | Hard shale |
| 2248 | Hard shale |
| 2337 | Shale |
| 2408 | Shale and lime shells |
| 2460 | Hard shale and shells |
| 2517 | Shale |
| 2582 | Shale and lime shells |
| 2630 | Shale |
| 2636 | Hard lime conglomerate TOTAL DEPTH |

Shell Petroleum Corp.:

| | |
|---|---|
| 350-60 | Top Washita |
| 410-30 | Top Georgetown |
| 720-40 | Top Kiamichi |
| 755-65 | Top Goodland |
| 840-50 | Top Walnut |
| 930-40 | Top Paluxy |
| 1060-80 | Top Glen Rose |
| 1440 | Top Anhydrite |
| 1530-40 | Top Travis Peak |
| 1970-80 | Top Pennsylvanian |

Stanolind Oil & Gas Co.:

| | | |
|---|---|---|
| 355 | Top Grayson | + 133 |
| 435 | Top Main Street | + 53 |
| 755 | Top Goodland | — 267 |
| 840 | Top Walnut | — 352 |
| 935 | Paluxy (Probably) | — 447 |
| 1060 | Top Glen Rose | — 572 |
| 1440 | Top Anhydrite | — 952 |
| 1448 | Bottom Anhydrite | — 960 |
| 1488 | Top Travis Peak | —1000 |
| 1550 | Top Travis Peak reds | —1062 |
| 1970 | Top Paleozoic (Pennsylvanian, probably) | —1482 |
| 2098 | Top soft waxy green-gray shale | |

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**COMPANY: Trinity Well**
**LESSOR: Negro Park, Well No. 33**
**LOCATION: Oak Cliff. Approx. 2,650' to N line & 150' to E line of Elizabeth Robertson Hrs. Surv. No. 21.**
**ELEVATION: 405'**

| | |
|---|---|
| 0-10 | Soil |
| 18 | Gravel and sand |
| 48 | White rock |
| 172 | Blue shale |
| 285 | Lime rock |
| 425 | Yellow lime rock |
| 510 | Blue shale |
| 530 | Sand rock |

| | |
|---|---|
| 532 | Hard sand rock |
| 567 | Water sand |
| 581 | Sand rock and gray marl |
| 595 | Sand rock and blue shale |
| 606 | Shale and hard sand |
| 625 | Water sand |
| 639 | Hard sand |
| 653 | White and gray marl |
| 663 | Sand rock |
| 690 | White marl |
| 705 | Hard water sand |
| 711 | Sand rock |
| 724 | White and red marl |
| 728 | Hard, sandy lime rock |
| 737 | Hard sand rock |
| 761 | Red and gray marl |
| 777 | Shale and sand rock |
| 790 | Hard water sand |
| 808 | Water sand |
| 822 | Shale and sand rock |
| 830 | Water sand |
| 858 | Marl and sand rock |
| 867 | Blue marl |
| 886 | Water sand |
| 897 | Sand rock |
| 922 | Gray marl |
| 952 | Light blue shale |
| 987 | Light blue marl |
| 995 | White lime |
| 1102 | Weatherford lime |
| 1216 | White lime |
| 1218 | Lime rock |
| 1251 | White lime |
| 1271 | White marl |
| 1283 | White lime rock |
| 1314 | White lime |
| 1348 | Weatherford lime |
| 1355 | Sand rock |
| 1357 | White lime |
| 1367 | Weatherford lime |
| 1455 | White lime |
| 1464 | Hard water sand |
| 1475 | Sand rock |
| 1486 | Water sand |
| 1496 | Hard water sand |
| 1504 | Sand rock |
| 1524 | Hard water sand |
| 1560 | Water sand |
| 1574 | Hard water sand |
| 1592 | Water sand |
| 1621 | Hard water sand |
| 1624 | Water sand |
| 1628 | Lime rock |
| 1635 | Sandy lime |
| 1639 | Lime rock |
| 1643 | Hard, sandy lime |
| 1670 | White lime |
| 1692 | Lime and shale |
| 1695 | Lime rock |
| 1737 | Lime and blue shale |
| 1819 | White lime |
| 1828 | Lime rock |
| 2071 | Lime and shale |
| 2111 | Water sand |
| 2122 | Lime rock |
| 2208 | Sand rock |
| 2228 | Water sand |
| 2246 | Sand rock |
| 2258 | Hard, water sand |
| 2280 | Water sand |
| 2472 | Sand rock |
| 2772 | Trinity sand |
| | TOTAL DEPTH |

**COMPANY: Union Terminal Co.**
**LOCATION: Union Terminal Station, City of Dallas**
**ELEVATION: 417.14′ U. S. G. S.**

| | |
|---|---|
| 0 -10′ 0″ | Filled-in soil; clay and sand |
| 65′ 0″ | White rock |
| 95′ 4″ | White rock |
| 565′ 0″ | Blue shale with a few thin sand rocks and sulphur balls |
| 575′ 0″ | Sand rock |
| 590′ 0″ | Water sand |
| 591′ 3″ | Hard sand rock |
| 596′ 0″ | Water sand |
| 606′ 0″ | Water sand, red and blue marl |
| 630′ 0″ | Blue shale and sand rocks |
| 665′ 0″ | Water sand |
| 844′ 0″ | Red, blue to grey shale and sand rock |
| 860′ 0″ | Water sand |
| 970′ 0″ | Red, blue and grey plastic shales |
| 982′ 5″ | Weatherford lime rock |
| 989′11″ | Lime rock |
| 1003′ 0″ | Lime rock and blue shale layers |
| 1027′ 0″ | Lime rock |
| 1052′ 3″ | Pink plastic shales |
| 1069′ 3″ | Lime rock |
| 1073′ 3″ | Light blue shale |
| 1091′ 3″ | Lime rock |
| 1120′ 5″ | Light blue shale, lime rock and sulphur balls |
| 1138′11″ | Lime rock |
| 1182′ 6″ | Lime rock and marl |
| 1186′ 6″ | Lime rock |
| 1192′ 6″ | Lime rock and sulphur balls |
| 1193′ 6″ | Soft lime rock |

| | |
|---|---|
| 1194′ 6″ | Lime rock |
| 1201′ 6″ | Hard lime rock |
| 1213′ 6″ | Lime rock and marl |
| 1217′ 0″ | Hard lime rock |
| 1235′ 9″ | Lime rock and marl |
| 1242′ 9″ | Hard lime rock |
| 1247′ 9″ | Light blue marl |
| 1261′ 3″ | Lime rock and pyrites |
| 1264′ 3″ | Hard lime rock |
| 1274′ 3″ | Hard lime rock and pyrites |
| 1289′ 3″ | Hard lime rock |
| 1295′ 3″ | Tough and soft lime rock |
| 1309′ 4″ | Hard lime rock and sulphur |
| 1310′ 4″ | Light blue marl |
| 1319′ 8″ | Hard lime rock |
| 1323′ 8″ | Light to dark blue marl |
| 1325′ 8″ | Sand rock and blue marl |
| 1330′ 8″ | Sand rock and blue marl |
| 1342′ 8″ | Dark blue marl and lime rock |
| 1353′ 8″ | Blue marl |
| 1377′ 7″ | Hard lime rock |
| 1398′ 1″ | Hard and tough lime rock |
| 1410′ 1″ | Streaks of sand, shale and rock |
| 1425, 1″ | Streaks of hard, tough lime rock |
| 1432′ 1″ | Light grey shale |
| 1435′ 2″ | Tough lime rock |
| 1448′ 5″ | Streaks of hard, tough lime rock |
| 1453′ 5″ | Grey sandy shale |
| 1465′ 1″ | Hard, fine water sand |
| 1477′10″ | Hard water sand and shale |
| 1480′10″ | Water sand, hard sand rock |
| 1481′ 7″ | Hard sand rock, water rock |
| 1485′ 7″ | Hard, sharp sand rock |
| 1494′ 8″ | Hard, close water sand |
| 1498′10″ | Soft water sand |
| 1514′10″ | White marl and sand rock |
| 1522′ 8″ | Light blue marl |
| 1524′ 8″ | Light water sand |
| 1542′ 8″ | Hard water sand |
| 1551′ 8″ | Marls and sand mixed |
| 1560′ 4″ | Streaks of sand rock and marl, hard water sand |
| 1562′10″ | Hard water sand |
| 1564′10″ | Blue marl |
| 1578′ 4″ | Hard water sand |
| 1595′ 5″ | Hard water sand |
| 1609′11″ | Hard water sand |
| 1616′ 8″ | Sand rock and blue marl |
| 1626′ 8″ | Hard water sand |
| 1632′ 3″ | Medium hard water sand |
| 1650′ 6″ | Hard water sand |
| 1656′10″ | Hard, sandy lime rock |
| 1660′10″ | Sandy shale |
| 1680′ 4″ | Hard, sandy lime rock |
| 1683′ 4″ | Hard, sandy lime rock, light blue shale |
| 1684, 4″ | Hard, sandy lime rock and blue shale |
| 1686′10″ | Lime rock with shale and marl |
| 1690′ 3″ | Lime rock with shale and marl |
| 1709′ 8″ | Hard sand and lime rock |
| 1712′ 8″ | Hard lime rock, thin layers of marl |
| 1727′ 8″ | Hard lime rock, thin layers of marl |
| 1731′ 8″ | Hard, gritty blue and grey shale |
| 1760′ 5″ | Lime rock and marl |
| 1766′ 5″ | Layers of hard sand rock |
| 1779′ 3″ | Hard sand rock, white water sand |
| 1791′ 3″ | Layers of lime rock and marl |
| 1801, 3″ | Light blue marl |
| 1804′ 9″ | Thin layers of marl and lime rock |
| 1807′ 9″ | Hard lime rock |
| 1825′ 7″ | Shelly lime rock, shelly shale |
| 1828′ 7″ | Hard lime rock |
| 1859′ 2″ | Shelly lime rock |
| 1864′ 2″ | White marl |
| 1865′ 0″ | Lime rock |
| 1881′ 0″ | Shell and shale |
| 1906′ 5″ | Lime rock |
| 1929′ 7″ | Hard lime rock |
| 1939′ 7″ | Lime rock |
| 1953′ 7″ | Hard lime rock |
| 1974′ 7″ | Porous lime rock and sand |
| 1994′ 1″ | Hard lime rock |
| 1996′ 1″ | Shale |
| 2107′10″ | Hard lime rock |
| 2112′10″ | Sand rock |
| 2129′ 3″ | Sandy lime rock |
| 2131′ 8″ | Sand and lime rock |
| 2134′ 8″ | Lime rock |
| 2150′ 2″ | Hard, white lime rock |
| 2172′ 7″ | Hard, white lime rock |
| 2173′11″ | Blue, sandy lime rock |
| 2184′ 7″ | Hard lime rock |

| | |
|---|---|
| 2195′ 7″ | Hard sand rock |
| 2216′ 7″ | Glen rose sand rock |
| 2228′ 9″ | Hard and soft Glen Rose |
| 2247′ 5″ | Glen Rose |
| 2264′ 3″ | Glen Rose sand and shale |
| 2275′ 9″ | Glen Rose |
| 2307′ 9″ | Glen Rose, hard sand rock |
| 2320′ 1″ | Glen Rose sand and shale |
| 2329′ 1″ | Glen Rose sand, red, green, and pink marl |
| 2338′ 1″ | Glen Rose sand |
| 2339′ 7″ | Sandy marl |
| 2352′ 7″ | Hard sand rock to red marl |
| 2357′ 5″ | Blue marl and sand rock |
| 2358′ 9″ | Hard sand rock |
| 2383′ 9″ | Sand rock |
| 2397′ 9″ | Sand rock and white marl |
| 2402′ 2″ | Sand rock |
| 2407′ 2″ | Red marl and sand rock |
| 2423′ 2″ | Red marl and sand |
| 2440′ 7″ | Red marl and sand rock |
| 2455′ 7″ | Marl and sand |
| 2460′ 7″ | Hard sand |
| 2477′ 1″ | Sand gravel and marl |
| 2489′ 5″ | Sand and marl |
| 2494′ 5″ | Trinity sand and marl |
| 2583′ 7″ | Trinity sands |
| 2621′ 1″ | Sand |
| 2625′ 1″ | Hard sand |
| 2626′ 1″ | Hard sand rock |
| 2630′ 1″ | Hard water sand |
| 2631′ 5″ | Hard sand rock |
| 2641′ 5″ | Trinity sand |
| 2652′ 5″ | Sand |
| 2675′ 0″ | Hard sand |
| | TOTAL DEPTH |

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**COMPANY: Plaza Oil Co.**
**LESSOR: Davidson, Well No. 1**
**COMM.: 1-25-38, COMP.: 10-1-38**
**COUNTY: Dallas**
**LOCATION: 1 mile NW of Seagoville 1650′ from NEL and 330′ from SEL of survey. 330′ out of SE corner of B. J. Davidson 40 acre tract. R. D. Fallon survey.**
**ELEVATION: 434′**
**CSG. RECORD: 12″-61′**

| | |
|---|---|
| 0-320 | Shale, sand and gravel |
| 361 | Sand and shale |
| 533 | Sandy shale |
| 545 | Shale |
| 1098 | Chalk |
| 1130 | Broken lime |
| 1159 | Shale |
| 1323 | Shale and shells |
| 1422 | Sandy shale |
| 1560 | Shale |
| Cored: | 1560-80 Rec. 12′ 9′ Black shale 3′ Shaly sand, med. porous |
| Cored: | 1580-92 Rec. 2′ black shale |
| 1638 | Shale and sand |
| 1677 | Sandy shale and lime |
| 1742 | Shale and sandy lime |
| 1745 | Lime |
| 1770 | Lime and shale |
| 1805 | Sand and shale |
| 1814 | Lime and shale |
| 1835 | Shale |
| 1970 | Sandy shale |
| 2000 | Broken lime |
| 2056 | Lime |
| 2152 | Lime and pyrites |
| 2265 | Lime |
| 2416 | Broken lime |
| 2580 | Lime |
| 2589 | Shale and lime shells |
| 2597 | Lime |
| 2648 | Broken lime |
| 2680 | Shale and lime shells |
| 2700 | Broken lime |
| 2701 | Sand |
| Cored: | 2701-14 Rec. 3′ white firm, slightly porous fine-grained sand, no shows. |
| Cored: | 2714-21 Rec. 6″ hard sandy lime |
| 2769 | Broken lime |
| Cored: | 2769-83 Rec. 1′ grenish gray sandy lime. |
| 2779 | Broken lime |
| 2787 | Sand |
| 2829 | Broken sand and lime |
| 2836 | Lime |
| 2851 | Sand |
| 2859 | Sandy lime |
| 2893 | Lime |
| 2972 | Broken lime |
| 3000 | Lime |
| 3064 | Broken lime |
| 3087 | Sand and shale |
| 3137 | Sand and shale |
| 3147 | Sandy lime |
| 3216 | Broken lime |
| 3289 | Lime |
| 3327 | Lime and shale |
| 3341 | Lime |

3392 Lime and shale and stks. sand
3453 Anhydrite
3599'6" Lime
TOTAL DEPTH 3599'6"

Shell Petroleum Corp.:

| | |
|---|---|
| 510-20 | Top Gober Austin chalk |
| 620-30 | Top Austin Chalk (Probably) |
| 1080-90 | Top Eagle Ford |
| 1510-80 | Sample skip |
| 1580-92 | In Woodbine (Cored) |
| 1950-60 | Top Grayson (Washita) |
| 1980-2000 | Top Georgetown lime |
| 2680-90 | Top Paluxy |
| 2770-83 | In Paluxy (In sample) |

Stanolind Oil & Gas Company:

| | |
|---|---|
| 1080 | Base Austin chalk |
| 1510 | Top Woodbine |
| 2000 | Top Georgetown |
| 2700 | Top Paluxy |

Driller:

| | |
|---|---|
| 3392 | Top Anhydrite |
| 3435 | Base Anhydrite |
| 3435 | Top Rodesa lime |

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**COMPANY: McNeil & Matthews**
**LESSOR: Seaton, Well No. 1**
**COUNTY: Dallas**
**LOCATION: Approximately 5300' from South line and 2800' from West line, Dallas County**

308 Core. Laminated, very fine sandy, gray, fine micaceous shale. Slightly calcareous.

329 Core. Gray sandstone, rather fine grained and somewhat shaly. Porosity fair Non-calcareous.

382 Core. Gray, medium grained, sub-angular, friable sandstone. Porosity excellent. Well sorted, slightly glauconitic.

538. Core. Nodular, gray fossiliferous limestone with marly and shaly patches and mottlings.

800 Cuttings. Gray and darker gray, fossiliferous, partly argillaceous limestone with some chalky gray shale; some chalky gray shale, tized dark shale. 40% limestone; 60% shale.

974 Core. Shaly, gray sandstone. Somewhat calcareous; well rounded, medium fine quartz grains.

987 Core. Like above. More friable.

1100-05 Cuttings. 10% limestone; 5% sandstone; 85% shale. Gray limestone with numerous shale fragments, smooth dark shale and gray shale. Small amount of even grained hard sandstone.

1160 Cuttings. 75% limestone; 25% shale. Light gray fossiliferous limestone with scattered pyritic mottlings.

1210 Cuttings. 80% limestone; 20% shale. Partly mottled, marly limestone, some pure, all very fossiliferous Very fossiliferous with abundant pyritic mottlings. Glen Rose limestone.

1245 Core. Gray smooth, fine grained non-calcareous shale.

1286 Core. Light gray, somewhat marly, coquina limestone. Made up of loosely cemented miliolids and other microfossils.

1315 Cuttings. 20% limestone; 80% shale. Gray limestone, mostly gray shale with traces of red and green shale.

1356 Core. Light gray coquina limestone, made up of microfossils and some scattered oolites.

1506 Core. Gray granular fossiliferous limestone with a few miliolids. Noted number of large shell fragments.

1506 Core. Like above except that the limestone might be termed coquinoid. Miliolids common.

1524 Cuttings. 90% limestone; 10% shale. Granular, gray fossiliferous limestone partly coquinoid and dark gray shale.

1530 Cuttings. 80% limestone; 20% shale. Like above.

1632 Cuttings. 10% limestone; 90% shale. Gray granular, fossilferous limestone and gray argillaceous mottled fossiliferous limestone with mostly dark gray shale.

1634 Core. Friable, coarse, well sorted, gray, medium rounded quartz sand. Excellent porosity.

1657 Core. Gray, fine grained, friable sandstone, shaly.

1670-74 Core. Gray friable, medium fine, well sorted and rounded sandstone.

1676-84 Core. Pinkish, fine grained non-calcareous shale.

1707 Core. Medium coarse, gray, friable sandstone. Well sorted and rounded.

1760 Core. Porous, granulated, dolomitic sandy limestone.

1763 Core. Lime sandstone. Dolomitic.

1817 Core. Sandy marl with gray limestone inclusions. Fossiliferous.

1817-19 Core. Limy, fine grained gray sandstone.

1823 Cuttings. 10% limestone; 5% sandstone; 85% gray and red shale. Noted **Orbitolina** sp.

1900 Core. Greenish and gray shaly sandstone with sandy dolomite inclusion.

1926 Bit sample. White, soft limy or chalky shale carrying considerable fine sandstone.

1930 Core. Finely sandy red shale. (Depth approximate)

1968 Core. Coarse porous friable sandstone with excellent porosity.

2002 Core. Medium coarse, porous, friable sandstone.

2045 Core. Brownish dark gray calcareous shale.

2070 Cuttings. Sample made up largely of fragments of of sandy dolomite, varicolored chert fragments and pebbles and some red, green, and gray shale. Conglomerate obscured by cavings.

2200 Cuttings. Gray brown and reddish to yellow shales. Mostly dark gray shale, compact but not hard.

2222 Cuttings. Like above.

2237 Cuttings. Like above.

2240 Cuttings. Like above. shale darker in color and shows slickensides on some fragments.

2300 Cuttings. Like above.

2400 Cuttings. Dark gray compact shales slightly sandy in part.

2412 Cuttings. Like above. Few slickensides.

2435 Core. Upper. Hard. slate-like black shale showing slickensides on most faces.

2435 Core. Lower. Like above.

2485 Cuttings. Dark gray, partly sandy, compact shales.

2655 Core. Hard, slate-like black shale.

2655 Core. Like above.

# PART IV
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## CORRECTIONS

p. 8, figure 7 is on page 35, not page 32 as indicated in Contents.

p. 8, figure 8 is on page 36, not page 35 as indicated in Contents.

p. 16, line 12, first paragraph—For "Compred" read *compared.*

p. 24, line 15, second paragraph—For "inches" read *inch.*

p. 50, line 17, fifth paragraph—For "*dallasensis*" *read austinensis.*

p. 52, line 5, first paragraph—For "*unlulato-*" read *undulato-*

p. 95, last line—For "the" read *to*

p. 96, line 11, second paragraph—For "become" read *became.*

p. 109, between lines 3 and 4 insert the following: ". . . *of the Woodbine varies greatly between these areas. The upper part of* . . ."

p. 110, lines 11-12—For "identifield" read *identified.*

p. 110, line 9—For "distinguished" read *differentiated.*

p. 110, line next to last on page—For "appears, probably due" read *appears probable, due.*